

Human / Storage

The H.I.V.E System

Master Thesis explanatory document

King Wah Mak (Jim)

Primary Supervisor: Chris Murphy
Associate Supervisor: Jeanette Budgett
Expert Consultants: David Turner, Kerry Francis

Abstract

From memory, in the city of Hong Kong where I used to live during my childhood, there were fewer people and fewer cars on the streets; buildings were shorter and they were not densely packed together; sky was clearer and seemed to be bigger. Obviously the city has grown a lot since, the urban area had spread dramatically to occupy the fast growing population. In order to link the old to the new, traffic infrastructure is also being developed in a parallel pace to cope with the speedy development. However, the develop-able land is so scarce in a city such as Hong Kong that inner-city redevelopment also takes place simultaneously, with the same piece of land accommodating more people with yet taller buildings. More people in the city mean more vehicles on the street and substantial upgrade to the existing traffic infrastructures is inevitable. However, upgrading an inner-city road is far more complicated than laying down a brand new one in a new town at the city fringe.

The method of road widening is rarely the suitable option for the already developed inner city. Expansion or upgrade for traffic facilities has predominately taken place skyward over pre-existing roads in a multi-layer scale. Flyovers, viaducts or overpasses, whilst all these vehicle bridges assist the arteries of the city in reducing traffic congestion, the tradeoff is the wasted space beneath. With the exception of small portion of spaces required at the abutments for the supporting piers to prop-up the bridge slabs, the majority of spaces beneath the traffic viaducts serve little purpose.

According to Rem Koolhaas on 'Junkspace'¹, "The built product of modernization is not modern architecture but Junkspace."² In our modern approach to built structures we build for the function but instantaneously we also the build "non-function". The under-bridge spaces are being created unintentionally, with an end use determined usually later. Occasionally, there are landscaped parks, though temporary car parks are the most common plug-in. The worst situation is when they are left empty and fenced off creating a visual "no man's land". It does not make sense seeing such wastage of land in the city like Hong Kong where land is so precious. I am surprised that better utilization for these under-bridge spaces has not yet explored.

1 Rem Koolhaas, "Junkspace," *October*, Vol.100, Obsolescence. (Spring, 2002), pp. 175-190.

2 Ibid. P. 175.

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Introduction

Hong Kong is a highly developed Asian city, and probably over-developed in terms of living density. The city has a population of 7.1 million but only a landmass of 1,104 km² that is largely comprised of mountain ranges with little flat areas. It makes Hong Kong one of the most densely populated cities in the world. With the inadequate amount of buildable land, housing is packed so closely together that urban inhabitants can almost shake their neighbors' hands through windows in their apartments!

The shortage of government subsidized Public Housing directly leads to the rise of the 'cage home' and 'cubical flat' problems (i.e. A 1,000 ft² flat subdivided into 10 rooms and more). Although there exist many methods to develop land for housing needs, the annual housing provision remains far behind the demand for accommodation. In addition, each of these development methods also contains implementation problems that reduces their viability and stretches the developmental period.

Over the years, mass high-rise developments without careful planning has exacerbated the environmental predicament that the citizens of Hong Kong find themselves in; the already hot and humid sub-tropical city of Hong Kong is hotter than ever and wind ever more stagnant. Beside the thermal comfort issue, the hot stagnant environment also leads to hygiene problems, over-consumption on energy and all sorts of city pollutions. Although high-rise housing is an inevitable solution for the city like Hong Kong due to its insignificant amount of useable land, nonetheless it should be involved with careful planning and design to modify the microclimate for providing more livable environment. Erecting more high-rises randomly wherever land is available may only mitigate the housing shortage problem in short term, but holistically, the whole city need to be renewed, recycled, rebuilt, regenerated and revitalized into a more sustainable state in terms of economic, social and environmental aspects.

Under-bridge space is the only available land in the city that does not appeal to developers. The government deems the best land use activity to be public spaces, such as parks, recreation, public toilet or with those smaller spaces, planted areas. However I see more potential in these spaces as useful resources that will not just mitigate the housing problem, but may also hold the key to transform the city into a future Utopia. In this thesis, I will demonstrate the significance of the housing shortage problem in Hong Kong, how is it affecting the people and the city, then give an example of how the ideal city may look like, how this may be achieved, and demonstrate what role the under-bridge spaces will pay in the shaping of the future city.

The super dense city

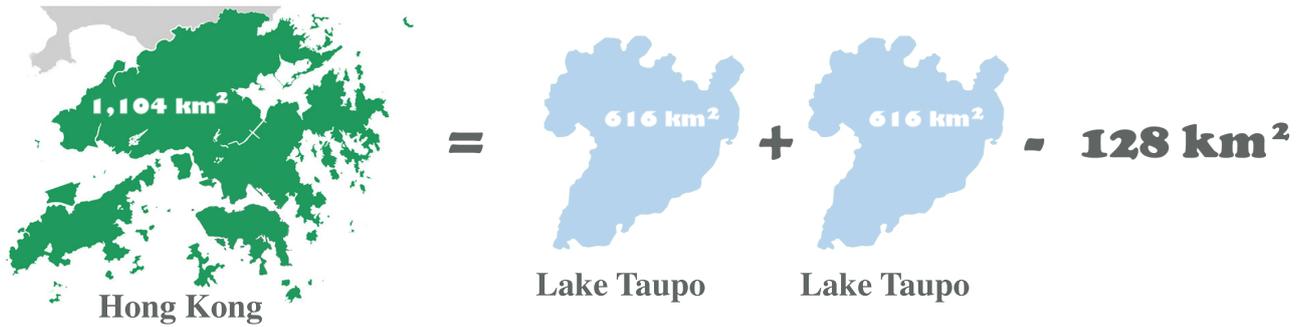


Fig 1. Landmass comparison: Hong Kong VS Lake Taupo. Illustration by author.

Hong Kong is one of the two Special Administrative Regions (SARs) of China, the subtropical city consists of Hong Kong Island, Kowloon Peninsula, New Territories and over 200 outlying islands, and subdivided into 18 geographic districts. The landmass of Hong Kong³ is 1,104 km², which is 128 km² smaller than twice the size of Lake Taupo⁴. With a large amount of hilly terrain and 40% of the land area classified as country parks and nature reserves, that there is approximately only 24% of the land remaining to accommodate its 7.1 million inhabitants. It makes Hong Kong the 7th densest city⁵ in the world with the urban density of 25,900 people per km². This compares with Macau⁶ (the 2nd SARs of China) as the 4th densest city with the urban density of 27,000 people per km², and Dhaka, Bangladesh places at No.1 with 44,400 people per km². For comparison, Auckland, New Zealand⁷ is at 714th place with 2,400 people per km². Population of Hong Kong does not spread evenly across its urban area and Kowloon holds all top five most densely populated districts⁸: Kwun Tong with 56,303 people per km², Yau Tsim Mong 44,946, Wong Tai Sin 44,891, Shum Shui Po 40,175 and Kowloon City at 37,849. Beside Kowloon Bay and Yau Tsim Mong that all other three districts are predominately resides with the least educated people with the income below average and the higher percentage in elderly. Furthermore, these are some of the earliest developed towns in Hong Kong.

3 *Hong Kong in Figures*, 2012 ed. (Hong Kong: Census and Statistics Department, 2012), pp. 8-10. <http://www.censtatd.gov.hk/hkstat/sub/sp140.jsp?productCode=B1010006>.

4 Wikipedia, s.v. "Lake Taupo," accessed September 14, 2011. http://en.wikipedia.org/wiki/Lake_Taupo.

5 *Demographia World Urban Areas (World Agglomerations)* 8th Annual ed. (April 2012), p. 130. <http://www.demographia.com/db-worldua.pdf>.

6 *Ibid.* P. 130.

7 *Ibid.* P. 154.

8 *Hong Kong Population History & 2011 Census*. Demographia. <http://www.demographia.com/db-hkdbd-19912001.pdf>.

Shortage of developable land

After the World War Two in 1945, the population of Hong Kong had dropped from 1.6 million to 600,000 due to scarcity of food and emigration. Five years later in 1949 in the beginning of the communist revolution in Mainland China, the population of Hong Kong started to increase, with many thousand refugees moving across the border from Mainland China. This not only increased the population, but also diversity of skills and vast pool of capital. Spurred on by the continuous number of immigrants from Mainland China, the population of Hong Kong has never stopped growing since⁹.

There are other contributing factors that boosted the population size, including 284,901 (recorded in 2010) foreign domestic helpers from Philippines, Indonesia and Thailand¹⁰, and a low death rate compared to a high birth rate (Hong Kong people have the 2nd longest life span average of 82.2 years old).¹¹ There has been an average increase of 1 million people per decade, which makes it 7.1 million in the most recent record in 2012. Because of the ultra-fast growing rate of the population, the land resource that is suitable for housing is diminishing rapidly. In 2000, there was only approximately 27km² (2.5% of Hong Kong total landmass) of vacant develop-able land, with a portion of it already under construction¹². The largest single plot of develop-able land is currently the old Kai Tak Airport¹³ with 3.2km², but this reclaimed land has been vacant for over 13 years. As the old airport retired in 1997, the harbour protection laws were also established which enforced zero-reclamation to Victoria Harbour. This restriction contributes to the land supply shortage.

9 Wikipedia, s.v. "Hong Kong," accessed September 11, 2011. http://en.wikipedia.org/wiki/Hong_Kong.

10 Wikipedia, s.v. "Foreign Domestic Helpers in Hong Kong," accessed April 10, 2012. http://en.wikipedia.org/wiki/Foreign_domestic_helpers_in_Hong_Kong.

11 Wikipedia, s.v. "List of Countries by Life Expectancy," accessed April 10, 2012. http://en.wikipedia.org/wiki/List_of_countries_by_life_expectancy.

12 "Consultancy Study to Analyse Broad Land use Pattern of Hong Kong." Department of Geography, The Chinese University of Hong Kong. Posted April 2001. http://www.pland.gov.hk/pland_en/p_study/comp_s/lup/index_e.htm.

13 Kelvin Wong. "Abandoned Airport May Help Solve Hong Kong's Office Shortage." Bloomberg, September 30, 2011. <http://www.bloomberg.com/news/2011-09-29/abandoned-kai-tak-airport-may-be-answer-to-hong-kong-office-space-problem.html>.

Shortage of housing for the low-incomer

Housing shortage is the topic that most regularly hits the headlines in Hong Kong. In 2010 there were about 121,000 people registered on the waiting list for public housing and the average waiting time is 3 years. News reporter Kelvin Wong from Bloomberg News wrote on 16th May 2012 “Leung Chun-ying, who in July will take over as Hong Kong's new Chief Executive, has vowed to increase housing supply to quell public discontent over a widening wealth gap in the world's most expensive place to buy a home.”¹⁴ A report on housing affordability over the next five, ten and twenty years has been submitted for helping the government to finalize annual housing budgets. The report “Housing Need and Affordability in Hong Kong 2011”¹⁵ done by the Royal Institution of Chartered Surveyors (RICS is an independent, representative professional body which regulates property professionals and surveyors)¹⁶, points out that on the basis of Hong Kong's housing demographics, the government of Hong Kong is only releasing land that is enough for 20,000 units per year for the next five years. This is 10% less than the required number of 22,000 units per year for the next five years, and the projected new completions in the next two years only has the average of 11,200 units a year, which is far below the city's needs.¹⁷ On the private housing sector, apartment prices are increasing rapidly. The so called “sandwich class”¹⁸ populace (the lower-middle class family earning between \$20,000 and \$40,000USD per year or \$10,000USD per year per capita, and not eligible for housing subsidy nor have the ability to purchase a private home) are being driven further away from achieving their goal of being private home ownership. The under supply of lower-cost private properties on the market is due to the vast amount of mainland Chinese buyers (over 35% of new property sales transactions were made by Chinese investors in 2011¹⁹) investing in Hong Kong luxury apartments, which leads the major developers such as Sun Hung Kai²⁰ Properties Ltd (the world's biggest developer by value) and Cheung Kong Holdings Ltd²¹ (controlled by Hong Kong's richest man, Li Ka-shing) have been over-concentrating on producing high-end housings. Simon Packard of Bloomberg News wrote on 29th Jan 2011 “Home prices in Hong Kong have been driven higher by record-low borrowing costs, a lack of new supply and an influx of Chinese buyers, Savills said. They have jumped more than 55 percent since the beginning of 2009, according to an index compiled by Centaline Property Agency Ltd., Hong Kong's biggest closely held broker”²². (Savills Plc is a global real estate services provider with more than 200 offices around the world)²³

14 Kelvin Wong. “China's Hong Kong Home-Buying Influx Wanes, Midland Says.” Bloomberg. May 16, 2012. <http://www.bloomberg.com/news/2012-05-16/mainland-chinese-occupy-less-in-hong-kong-s-new-home-market.html>.

15 Eddie C M Hui. *Housing Need and Affordability in Hong Kong*. (Hong Kong: RICS Asia, October 06, 2011). <http://www.ricsasia.org/webpage.php?id=10>.

16 Wikipedia, s.v. “Royal Institution of Chartered Surveyors,” accessed September 23, 2012. http://en.wikipedia.org/wiki/Royal_Institution_of_Chartered_Surveyors.

17 Hui. *Housing Need and Affordability in Hong Kong*. p. 4.

18 Wikipedia, s.v. “Sandwich Class,” accessed June 5, 2012. http://en.wikipedia.org/wiki/Sandwich_class.

19 Wong. “China's Hong Kong Home-Buying Influx Wanes, Midland Says.”

20 Simon Packard. “Hong Kong is World's Most Expensive Place to Buy Home on Property Shortage.” Bloomberg. January 29, 2011. <http://www.bloomberg.com/news/2011-01-28/hong-kong-is-world-s-most-expensive-place-to-buy-home-on-property-shortage.html>.

21 Ibid.

22 Ibid.

23 Wikipedia, s.v. “Savills.” Accessed April 10, 2012. <http://en.wikipedia.org/wiki/Savills>.

The current methods for land supply

For the private housing sector that Government-initiated land sales by auction or tender will continue to be the main land supply option. However, the government of Hong Kong is also working on other means of generating new land or regenerating the renewable land for both private and government developments.

1) **Wholesale Conversion / rezoning land** – Due to the cheaper labour, lower running cost and more affordable rent in Mainland China, Most industrial manufacturing activities in Hong Kong have gradually relocated to Mainland China since the early 1980s, and the consequences are the increase in vacancies and under-utilized industrial buildings in Hong Kong. According to Colliers market surveys in 2010, there are 1,314 older industrial buildings (considerably 15 years or older) in the territory that are eligible for wholesale conversion i.e. the Industrial Building Revitalization Scheme²⁴. With their extra strong structure these building can be easily converted into other uses such as retail, restaurant, hotel, office, etc. Kowloon East for example is a district that contains more than 300 industrial buildings eligible for wholesale conversion. The government is planning to convert this area into a business/commercial hub so-called 'CBD2' with more than 5,800,000m² of gross office floor area. This will be much bigger than the current Central (the current CBD location in the Hong Kong Island)²⁵. Practically, industrial buildings can be considered for conversion to residential uses only when they are located on sites where zoning allows for residential uses. Although the Land Department of Hong Kong is currently proposing to rezone about 0.3km² of industrial land for residential use²⁶, it is only a small percentage of the total industrial land of 19 square kilometers.²⁷

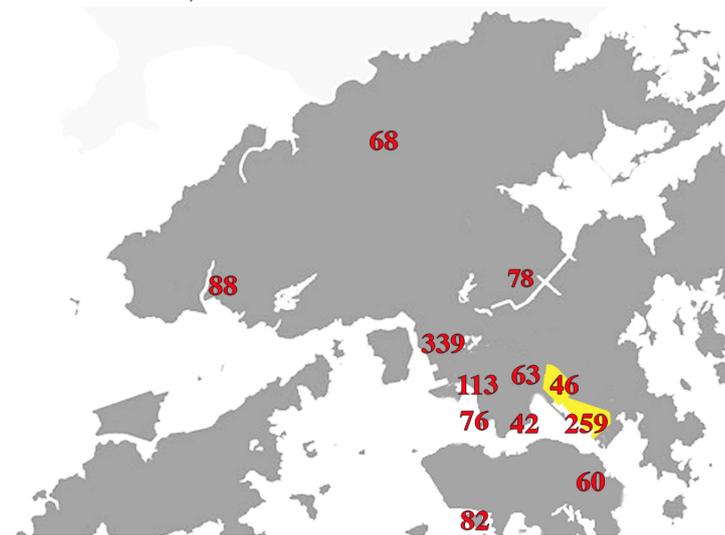


Fig 2. Number of industrial buildings eligible for wholesale conversions. The future CBD2 is indicated in yellow. Illustration by author.

24 Richard Kirke. *Re-vitalisation of Hong Kong's Industrial Buildings*. (Hong Kong: Colliers International, November 2011), p. 2. <http://www.colliersinternational.com/Country/HongKong/content/WhitePaper-Revitalisation-HK-Nov2011.pdf>.

25 Kelvin Wong. "Abandoned Airport May Help Solve Hong Kong's Office Shortage." Bloomberg. September 30, 2011. <http://www.bloomberg.com/news/2011-09-29/abandoned-kai-tak-airport-may-be-answer-to-hong-kong-office-space-problem.html>.

26 The Government of the Hong Kong Special Administrative region, Development Bureau. "Initiatives under Developing the Infrastructure for Economic Growth." Last Reviewed March 16, 2012. http://www.devb.gov.hk/en/about_us/policy/policy_agenda_1011/initiatives_under_developing/.

27 "Consultancy Study to Analyse Broad Land use Pattern of Hong Kong." Department of Geography, The Chinese University of Hong Kong. Posted April 2001. http://www.pland.gov.hk/pland_en/p_study/comp_s/lup/index_e.htm.

2) **Redevelopment** – At present, there are about 4,000 buildings in Hong Kong are over 50 years old. The number increases by 500 each year for the next 10 years. The government department in charge for rejuvenation of older urban areas in Hong Kong is the Urban Renewal Authority²⁸. There are two approaches for the residential building renewal. Firstly, 'rehabilitation' is a government subsidized program that helps property owners to prevent deterioration of their homes by applying appropriate repair and maintenance to their buildings. It is the speedier process for extending the building's useful life. However, the second scheme 'redevelopment' is more suitable for those shorter, older buildings with no elevators and lack of fire protection to meet the latest safety standards. (There are also two other types of urban renewal programs – 'Revitalization' as mentioned previously in 'Wholesale Conversion', which mainly consists of development outside the residential areas, and 'Heritage Preservation' primarily deals with conservations for historically important buildings.)



Fig 3. Buildings in Sham Shui Po that needs to be redeveloped.
Source: Hong Kong Stories. "Living below the Poverty Line: Cage Homes and Cubical Flats," video, 2010,
<http://www.hkstories.net/jmsc0007spring10/2010/03/poverty-sham-shui-po/>.

28 *People First: A District-based and Public Participatory Approach to Urban Renewal*. Urban Renewal Strategy. (Hong Kong: Information Services department, February 2011), p. 1. [http://www.ursreview.gov.hk/eng/doc/New%20URS%20\(Eng\).pdf](http://www.ursreview.gov.hk/eng/doc/New%20URS%20(Eng).pdf).

The Objectives of the Urban Renewal Scheme ²⁹

- (a) Restructuring and replanning of concerned urban areas.
- (b) Designing more effective and environmentally-friendly local transport and road networks within the concerned urban areas.
- (c) Rationalizing land uses within the concerned urban areas.
- (d) Redeveloping dilapidated buildings into new buildings of modern standard and environmental-friendly design.
- (e) Promoting sustainable development in the urban areas.
- (f) Promoting the timely maintenance and rehabilitation of buildings in need of repair.
- (g) Preserving buildings, sites and structures of historical, cultural or architectural value.
- (h) Preserving as far as practicable local characteristics.
- (i) Preserving as far as practicable the social networks of the local community.
- (j) Providing purpose-built housing for groups with special needs, such as the elderly and the disabled.
- (k) Providing more open space and community/ welfare facilities.
- (l) Enhancing the townscape with attractive landscape and urban design.

A redevelopment project usually takes 6 to 6 1/2 years to complete, the first 3 1/2 years being spend on planning, acquisition, land resumption and the clearance of buildings, with the remaining three years spend on site preparation and construction. In the acquisition of the old and dilapidated buildings, property owners either offer to sell their homes for a market value, or alternately participate in the Flat For Flat pilot scheme³⁰ (the FFF Scheme). In the FFF Scheme participants have three choices for the flat replacement equivalent to their current flat size. There are either a 7-year old Public Housing unit within the same or similar district(s), a unit in the future “Kai Tak Development”, or (the most popular choice) a flat in the completed redevelopment of the current address (In-situ Flat). The In-situ Flat replacement is designated to the lowest few floors (1st to 8th floor) only.³¹

29 Ibid. Pp. 2,3.

30 *Flat-For-Flat (Pilot Scheme) Pamphlet*. Urban Renewal Authority: Acquisition Policy. Last updated May 02, 2012. <http://www.ura.org.hk/en/schemes-and-policies/redevelopment/ura-implemented-projects/acquisition/domestic-properties.aspx>.

31 Ibid. Pp. 2-7.

3) **Reuse of ex-quarry sites** – There are currently two quarries (Anderson Road at 0.86km², and Lam Tei at 0.305km²) still operating for the excavation of building aggregates and rock products. Four ex-quarries are not yet/fully developed for future reuses. The Lamma Island site of 0.49km² is the only former quarry where restoration and rehabilitation has already finished and returned to the government for further development. The Lamma Island site will be utilized for recreational use, possibly as a water sport center and a sewerage pumping station. Restoration studies for the other three ex-quarries (Shek O, Cha Kwo Ling, and Mount Butler) are currently under way. They will eventually be rehabilitated.

Proposals for the reuses of quarry sites including the following: The Lam Tei site will be reverted back to a natural state as a self-sustaining ecosystem but also comprise a highway system. Shek O may be developed into both luxury low-rise housing and recreational facilities. Anderson Road has the greatest potential to be dedicated for public housing as it can house up to 30,000 residents. It is situated in the high density Kwun Tong District with 32 housing estates, contains the most public housing. The Choi Ying Estate is a nearby example of a ex-quarry that has been turned into a public housing estate.³²



Fig 4. Anderson Road Quarry. Photograph.

Source: http://www.pland.gov.hk/pland_en/p_study/prog_s/AndersonRoadQuarry/en/index.html.

32 “Quarry Rehabilitation in Hong Kong.” *Quarry Magazine*, Issue July 2002. pp. 23-31. http://www.agg-net.com/files/attachments/case-studies/quarry_rehabilitation_in_hong_kong_0.pdf.

4) **Rock cavern development** – According to a study of underground spaces in Hong Kong by the Civil Engineering and Development Department (CEDD), about 64% of the total land of Hong Kong is geologically suitable for rock cavern development and has the potential to house more than 400 government facilities in the future. Rock caverns are not suitable for residential use as they cannot provide natural sunlight, nevertheless they can provide land for public facility, storage, recreation, or even retail. Many precedents around the world confirm the rock cavern is a viable option. Facilities such as the National Archives and Gjøvik Stadium & Recreation Centre in Norway, Viikinmäki Wastewater Treatment Plant and Itäkeskus Swimming Hall in Finland, and Ammunition Facility in Singapore. The Hong Kong government is currently studying on the viability of 3 possible cavern sites, the idea being to relocate the existing government facilities into rock caverns, thereby freeing up the original land for other development, ideally housing. The Sha Tin Sewage Treatment Works can release 28 ha of waterfront land, Mt Davis & Kennedy Town Fresh Water Service Reservoirs can release 2 ha of prime land, and the Mui Wo Sewage Treatment Works and Refuse Transfer Station can release 2.5 ha waterfront land.³³

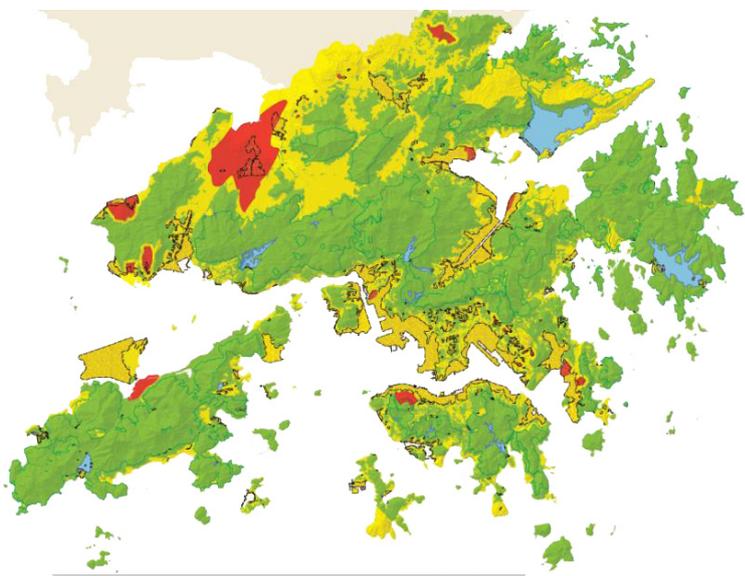


Fig 5. Cavern development suitability map.
Green – High to Medium (64%)
Yellow – Low to Very Low (30%)
Red – not Suitable (6%)

Source: Raymond K.S. Chan. “Future Cavern Development in Hong Kong,” illustration, 2011, <http://www.hkie.org.hk/hkiehkip/pdf/presentation/Day2/Ir%20Raymond%20K%20S%20CHAN.pdf>.



Fig 6. Hong Kong regional map.
Illustration by author.

33 Raymond K.S. Chan. “Future Cavern Development in Hong Kong.” (Hong Kong: Civil Engineering & Development Department, 2011), pp. 1-19. <http://www.hkie.org.hk/hkiehkip/pdf/presentation/Day2/Ir%20Raymond%20K%20S%20CHAN.pdf>.

5) **Land resumption** – Acquire land in the New Territories – Besides selling prime government land to the developers for private housing, the Hong Kong government continues to search for less expensive lands to purchase which are suitable for public housing. There is plenty of privately owned farm land and low-density country housing in the suburban areas of Hong Kong, predominantly in New Territories. In the past, land development in these rural lands would only be feasible where land acquired is developed into a whole new town rather than a new housing estate project. Alongside housing, planning will also involve traffic infrastructures, schools, public and recreational facilities, etc. Due to multiple ownership land acquisition can be a lengthy process with many constraints. Sometimes the owners resist selling their land for urban development, but most of the times they just not satisfy with the money being offer from the government. There are currently 9 new towns developed in the New Territories; Tsuen Wan (Tsuen Wan, Kwai Chung and Tsing Yi), Sha Tin (Sha Tin and Ma On Shan), Tuen Mun, Tai Po, Yuen Long, Fanling-Sheung Shui, Tseung Kwan O, Tin Shui Wai and North Lantau (Tung Chung and Tai Ho). Further developments for Tseung Kwan O and Tung Chung New Towns are being carried out, and the government is implementing the next possible new town development in the northern New Territories (Lok Ma Chau Loop)³⁴.

6) **Reclamation** – Reclamation has been the most widely used method for producing today's urban landmass in Hong Kong. There is approximately 68km² of total reclaimed land in Hong Kong³⁵, being 6% of the total landmass of city, 27% of all residential built-up area, 70% of all commercial built-up area, and 7 out of 9 new towns. Hong Kong has built a number of very large, world-class, facilities such as the Hong Kong International Airport³⁶ completed in 1998 and designed by Foster and Partners. The HKIA occupies the Chek Lap Kok Island situated on the north coast of Lantau. As the result of the reclamation process, the island's landmass increased four times from the original 310 ha to 1,248 ha. Hong Kong Disneyland³⁷ is a nearby attraction to boost its quiet local tourism industry. It is also part of the Lantau island development by reclamation. Its current landmass measures 22.4 hectares and will be expanded to 27.5 hectares with further reclamation. The next biggest development, to be completed in 2016 is also associated with reclamation. The Hong Kong-Zhuhai-Macau Bridge³⁸ will link the three major cities of China together and shorten the travel time from 3.5 hours to just 30 minutes. It will be one of the longest bridges in the world, and longest in Asia with 48km in length. It will also be one of the most complicated projects in the transport history that comprise of a section of underwater tunnel that emerges on

34 *New towns and New Major Urban Developments*. (Hong Kong: Information Services Department, December 2011). http://www.gov.hk/en/about/abouthk/factsheets/docs/towns&urban_developments.pdf.

35 “Enhancing Land Supply Strategy: Reclamation outside Victoria Harbour and Rock Cavern Development.” Bauhinia Seminar. March 15, 2012. http://data.bauhinia.org/events/2012/2012_03_15/doc/Ir%20Wai%20Chi-sing.pdf.

36 “Airport Authority News.” Issue 21. Corporate Affairs Department. Airport Authority Hong Kong. March/April 1999. http://civcal.media.hku.hk/airport/introduction/_content.htm.

37 Wikipedia, s.v. “Hong Kong Disneyland,” accessed September 14, 2011. http://en.wikipedia.org/wiki/Hong_Kong_Disneyland.

38 “Hong Kong-Zhuhai-Macau Bridge.” GDS Publishing. 2012, accessed June 10, 2012. <http://www.asianinfrastructure.com/news/newschinas-30-mile-bridge/>.

man-made islands. In addition, the West Kowloon Cultural District³⁹ (WKCD) Proposal is a HK\$21.6 billion project, involving world class architects such as Foster + Partners and OMA, on a 23-hectare of reclaimed land by the waterfront, The objective of the ten years old development is to boost cultural entertainment in Hong Kong and its ambition is to create a new art and cultural hub that hopefully increase public engagement.

In a press conference on 17th May 2011, The Permanent Secretary for Development (Works), Mr Wai Chi-sing announced this “it is necessary to resume land production by reclamation of an appropriate scale outside the Victoria Harbour so as to provide land to sustain the social and economic development of Hong Kong in the long run.”⁴⁰ The idea is to launch feasibility studies on a list of 10 possible reclamation sites at the outlying islands. Some of the proposals are rather ambitious, for example, the 1,500 ha of reclamation at the Cheung Chau Island will increase the original land by six times. Two other currently proposed sites both exceed 700 ha of reclamations: Lamma Island and the landfill between Peng Chau Island and Hei Ling Chau Island. All three sites are under consideration for large-scale development, however there is no clear indication from the government whether they will be solely for residential development, or a mixed-use development.



Fig 7 & 8. Before and after of the Chek Lap Kok Airport. Photographs.

Source: <http://civcal.media.hku.hk/airport/introduction/>.

39 West Kowloon Cultural District Authority. “Background of WKCD.” Last revision March 1, 2012. http://www.wkcd.hk/en/background_of_wkcd/index.html.

40 Press Releases. “Government Launches Study on Reclamation outside Victoria Harbour and Rock Cavern Development.” Posted May 17, 2011. Last reviewed March 16, 2012. http://www.devb.gov.hk/en/publications_and_press_releases/press/index_id_6575.html.

Complications of the six methods

Since the shortage for housing development is a current and imminent problem the Hong Kong Government has been urged to look for all options to increase the land supply. Their belief is that there is no single useful way of generating a significant amount land supply, all six methods should be encouraged and carryout at the same time. However, each of these methods has their advantages and disadvantages, contributions and tradeoffs that lead to abundant of complications that restrains and reduces their viability. Most commonly, housing project schedules are often delayed. In the worst cases, projects cannot even get passed preliminary stages.

'Wholesale Conversion / rezoning land' is a scheme more suitable for business/commercial expansion rather than residential use. Industrial buildings are much easier to convert into office block, as their interior layout, structural requirements and building regulations are typically very similar. When comparing with business/commercial expansion, residential conversion requires much more efforts in terms of cost and time. Moreover, in the perspective of building owners, commercial leasing is more profitable than residential rental by far. Zoning is another restraint that limits the practicality of changing industrial building into residential use. A wholesale conversion application can be launched anytime for converting industrial building into offices, but converting a single building into a residential apartment is virtually impossible unless a rezoning has been pre-completed for the surrounding area.

'Reuse of ex-quarry sites' can be carried out when the quarry site exhausted and potentially can be utilized for residential use. However, quarry rehabilitation is a long-term undertaking process, and typically takes more than 10 years to complete. There was only 1 former quarry rehabilitated and but decided not selected for residential use. The 2 remaining quarries in Hong Kong are still in operation and 3 ex-quarries are not yet rehabilitated. Therefore, these sites will not be ready in the near future for residential development, which they can only be classified into the land-reserved bank. Whilst land resources with quarry sites are very limited, they will relieve the housing shortage in a certain extend in the foreseeable future. Hopefully the majority of these lands can be dedicated for housing, especially public housing for those in need. Beside the inner city Anderson Road site, all other sites are located at remote areas that need much in a way of supplementary facilities to support housing needs. The lack of traffic infrastructure, public service, water and sewerage facilities, recreation, institution, cultural amenity and retail, etc. will make such housing development impossible. In addition, major public transportation such as a subway stations and bus terminals that provide multiple routes is a key feature for lower class housing. In contrast, public transportation is essential in areas of low-density luxury homes as private vehicle ownership is common. Hence, it is purely logical for the government's intention to develop the Shek O quarry site into high-end housing. Its location near the sea will ensure sea views and hence it can be sold for top dollars to the developers, and less supplementary facilities are required.

Land resumption: Acquiring land in the New Territories is possibly the most problematic method of increasing the land supply in Hong Kong. Negotiations over the purchase price are difficult because of multiple ownership. There are greedy people that ask for an unrealistic price well over the market value for their properties, hence the bargaining stage can be an endurance game and agreement can never be guaranteed or compromised. A small number of owners refusing to sell or asking for too much can endanger the success of the whole project. Although a smaller section of land can be much easier to acquire with fewer land owners involved, it may not be economically sensible for putting in all other supplementary facilities to support the small number of apartment blocks involved. The government's intended goal is to develop self-sufficient new towns on a large amount of acquired lands in the New Territories. These are very large projects that include land acquisition, master planning, design and construction. It is the most time consuming method out of all but with definitely the best desirable outcome at the end.

Rock cavern development is a relatively new method being introduced that will provide more land to meet Hong Kong's social and economic needs in the long term. It cannot provide housing on its own but it can release preoccupied valuable surface land for housing purpose. Cavern development can diminish community impacts by relocating sensitive facilities underground, these include incinerators, refuse transfer facilities, sewage treatment plants and so on. Simultaneously, the excavated material can also be sold as rock products for reclamation and construction use. Indoor sport centers, libraries, transportation terminals, warehousing, and even department stores can all exist in the underground network when the mastering of the techniques necessary. Rock cavern developments seem to have the most advantages for benefiting Hong Kong's land supply in a sustainable way. Yet it still needs a lot of feasibility studies to prove its viability. High construction cost could be a disadvantage.

Reclamation is the most controversial method, one that meets strong objections from environmental enthusiasts and harbour preservation organizations such as the Society for Protection of the Harbour Ltd. For the government, the Permanent Secretary for Development (Works), Mr Wai Chi-sing believes reclamation is a well-established method that can ensure sufficient land supply for the housing need. "Apart from creating new land, reclamation can also resolve the problems of handling surplus public fill and contaminated sediments. There is some urgency to resume reclamation for such purposes as the remaining capacity to handle surplus public fill in the fill banks and contaminated sediments in the mud pits will soon be running out."⁴¹

However, the opposition view is that whilst the usable empty land in the city is running low, there still is plenty of land in the New Territories to develop, given improved land management, planning and redevelopment techniques. The reclamation of the water should be treated as the last resort. In terms of ecological impact, the population for

41 "Government Launches Study on Reclamation outside Victoria Harbour and Rock Cavern Development." Press Releases. Development Bureau. Posted May 17, 2011. Last reviewed March 16, 2012. http://www.devb.gov.hk/en/publications_and_press_releases/press/index_id_6575.html.



Fig 9. Chinese White Dolphin (Dead). Photograph.
Sources: <http://www.cwd.gov.cn/en/yingshu.asp>.

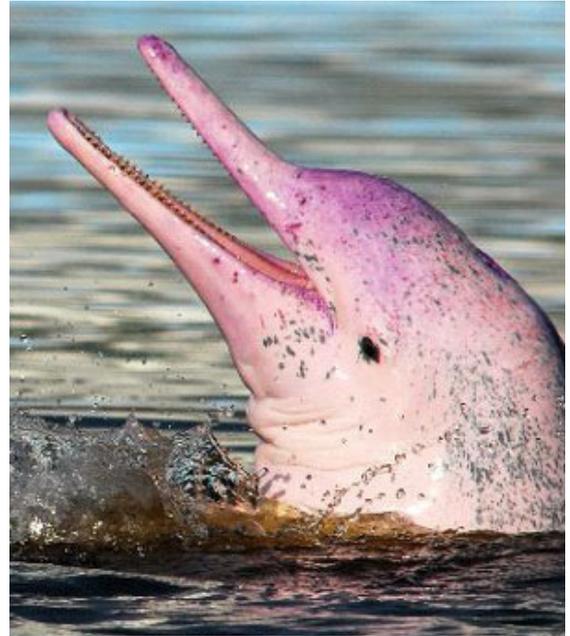


Fig 10. Chinese White Dolphin (Alive). Photograph.
Sources: http://www.dolphins-world.com/Chinese_White_Dolphin.html.

the endangered Chinese White Dolphin⁴² has dropped dramatically. In 1996, 150 of the endangered dolphins were estimated to habituate Hong Kong territorial waters (the Pearl River Delta). Now there are only 70 remaining. It has been reported that all calves born in 1996 have died due to air, water and noise pollutions caused by a series of reclamations at Lantau Island. While Hong Kong increased its land supply, dolphins' favorable habitat and food resources also being threatened and reduced.

Other environmental concerns also have an impact to the coastal areas. After the numerous of harbour reclamations, the Victoria Harbour has been narrowed to a state where people mock it by calling it the Victoria River. The increase in landmass in conjunction with its narrow streets and tall buildings decreased airflow remarkably. Therefore, the subtropical city of Hong Kong has to rely on artificial ventilation, typically air conditioning, which actually worsens the situation. Uncertain consequences associated with reclamation have also been addressed in J J Jiao's hypothesis for the Department of Earth Sciences, University of Hong Kong. In his research project on the impact of land reclamation on regional groundwater regime he states, "it has not been recognized yet that reclamation may change the regional groundwater regime, including groundwater level, interface between seawater and fresh groundwater, and submarine groundwater discharge to the coast. This will in turn cause engineering and environmental problems by modifying the infiltration capacity, flooding pattern, stability of slopes and foundations, and submarine groundwater discharge to the coast."⁴³

42 Helen Cheng et al., "Chinese White Dolphin." Participants Reports. Accessed June 12, 2012. <http://www.tesan.vuurwerk.nl/reports/bcelc/dolphin.htm>.

43 J J Jiao. *Preliminary Study on Impact of Land Reclamation on Regional Groundwater Regime*. (Hong Kong: CRCG, 2000), accessed June 5, 2012. <http://hydro.geo.ua.edu/jiao/reclamation.htm>.

Redevelopment can revitalize the dilapidated urban environment and improve the living conditions such as higher hygiene standard, safer security, easier access and better comfort. It usually achieves this by replacing the older, shorter and unsound buildings that the same piece of land will accommodate with more people through vertical densification. However, in the fast moving city like Hong Kong, the redevelopment of some of its older areas is relatively slow, explicitly noticeable in Sham Shui Po and Yau Ma Tei areas of Kowloon largely occupied by the low-income earners, new immigrants from the mainland and the elderly. Private developers are usually not interested in these rundown homes based on their current low average value in the market. Only when the government starts to renew the area with a new public housing estate, do nearby buildings become attractive for developers to acquire. For developers, due to the multiple ownerships of apartment buildings land acquisition can be a long process. Government acquisitions often involve purchasing up to 10 blocks at a time. This adds considerably to purchasing difficulties. The first hurdle for the purchasing of these properties has always been money. There are many who may wish to trade their current flat for a new flat in the future completed development, such as the FFF scheme introduced by the government. Therefore, temporary 'relocation'⁴⁴ becomes a major problem. It is unlikely that local flats will be available to accommodate these people during the period of demolition and construction. To address such problem, the government has prepared temporary facilities outside the urban area called the 'Interim Housing'⁴⁵. Po Tin Interim Housing in Tuen Mun, Sai Kung Interim Housing in Sai Kung, Long Bin Housing in Yuen Long, Kwai Shing Interim Housing in Kwai Chung and Shek Lei Interim Housing in Kwai Chungall, all locate in the New Territories. The current Interim Housing is not as successful as the ideal scheme set out to be. It was designed for those who are awaiting placement into public housing estates or residents who have been displaced by disaster, fire, redevelopment or other reasons. Conversely, people are actually unwilling to move too far away from their familiar neighborhood and unwilling to spend extra time and money for transportation to work. Speed has become a very crucial factor for the urban renewal scheme and to minimize holdups the government has established a new rule that will force the owners holding out against a better price, to sell their remaining units when 80% or more units of a building have been acquired⁴⁶.

44 "Enhancing Land Supply Strategy: Reclamation outside Victoria Harbour and Rock Cavern Development." Bauhinia Seminar. March 15, 2012. http://data.bauhinia.org/events/2012/2012_03_15/doc/Ir%20Wai%20Chi-sing.pdf.

45 Wikipedia, s.v. "Interim Housing," accessed March 21, 2012. http://en.wikipedia.org/wiki/Interim_Housing.

46 Jonathan Cheng. "Developers in Hong Kong Score Win." The Wall Street Journal. March 17, 2010. <http://online.wsj.com/article/SB10001424052748704059004575127534112450248.html>

The Public Housing HK



Fig 11. Hong Kong Public Housing Estate: Kin Ming Estate. Photograph.
Source: http://en.wikipedia.org/wiki/File:Kin_Ming_Estate.jpg.

The government program of providing affordable rental housing for those lower income residents was originated from the 1950s. All started from a fire in Shek Kip Mei on 25th December 1953. The fire destroyed thousands of shanty homes (also known as squatter settlement which are those slum housings that made out of scrap materials like plywood, corrugated metal or anything else the poor could find) and left 53,000 people homeless. Emergency resettlement buildings were built right at the fire scene for housing the fire victims. Multi-story mass re-housing was then introduced as the first public housing estate, the Shek Kip Mei Estate. Soon after, the Hong Kong Housing Authority was established and targeted at long-term improvement to the living environment of the low-income families. Today, there are generally two types of government-subsidized public housing schemes. First scheme called the 'Public Rental Housing' estate is a scheme that residential units are being rented on a discount rate to the low-income individuals or families who cannot afford the expensive rent in the market. Most of the Public Housing estates in Hong Kong belong to this type of housing scheme. The existing tenants can purchase their residential unit at later stage with a sale price much lower than market rate, which is known as the Tenants Purchase Scheme. The second scheme, known as the 'Home Ownership Scheme', consists of estates that are designed for those low-income residents who want to become homeowners but cannot afford to buy private housing. Hong Kong Housing Authority is selling these flats to the qualifiers at prices, which are heavily discounted and much lower than the market value. However, with the vast amount of public interests that only small amount of applicants can be offered the right for purchase based on a random draw system. These Home Ownership Scheme units are usually built adjacent to or within Public Rental Housing. Resale and mortgage in the second-hand market are restricted for eligible low-income residents. Currently, there are total of 206 public housing estates in Hong Kong with 740,000 units that house almost half of the city's population. Since the Public Housings are being sold or rented in a significantly lower price that their operational costs for these estates have to look for revenues from somewhere else. The sources of revenue consist of retail rentals and public paid car parks within the estates on the podium levels.⁴⁷

⁴⁷ Fung Ping Yan. Public Housing in Hong Kong Past, Present and Future. Chartered Institute Committee. [http://www.cih.org.hk/event_speaker_download/events2006100801/Public%20Housing%20in%20Hong%20Kong-%20Presentation%2024-9-06\(insert%20photo\).pdf](http://www.cih.org.hk/event_speaker_download/events2006100801/Public%20Housing%20in%20Hong%20Kong-%20Presentation%2024-9-06(insert%20photo).pdf).

Living below the poverty line

The annual Public Housing production cannot be balanced with its strong demand at the current state, and result in an average of 3 years waiting queue for the applicants. However, the actual waiting time can be 5 years or even 10 that the poor people have to look for the cheapest accommodation available, commonly the 'cage home' and 'cubical flat'. These two types of accommodations are typically found in those longstanding and unpleasant buildings among the early-developed urban districts of Hong Kong, such as Sham Shui Po, Yau Tsim Mong and Kwun Tong. Cage Homes comprise of open space/s that packed with single size triple bunk beds, share kitchen, share toilet/s and 700mm wide corridor as public space. A super compact design that each bed is being rent out to individual tenant as a multi task space for sleeping, eating, storage and leisure. It contains every personal belongings of the tenant like clothing, daily essentials, television and so on. The rusty steel cage provides security as well as common ventilation, and so as common flu. The monthly rent is starting from US \$100, and the age range of tenants is between 30s and 90s. A serious case of Cage Homes was found in the Kwun Tong area, where 300 occupants sharing the 2000ft² apartment.⁴⁸



Fig 12. Cage Homes. Photograph.
Source: <http://acidcow.com/pics/9367-the-life-of-homeless-people-in-hong-kong-18-pics.html>.



Fig 13. Cubical Flats. Video.
Source: <http://www.hkstories.net/jmsc0007spring10/2010/03/poverty-sham-shui-po/>.

Slightly upgraded version from the Cage Homes is the Cubical Flats. These flats are subdivide with partition walls, has properly secured door and sometimes even has a window. However, the smallest flat can be as small as 16.4ft², which is comparable to the size of a single bed. Some of these flats also share facilities like the Cage Homes does, other being self-contained suite with kitchen and bathroom that attracts a higher rent. Cubical Flats are typically housing a family of 3, 4 or more. A very broad range of inhabitants can be found in these bed-space apartments and cubicles, low-income earners, unemployed, elderly, and new immigrants from Mainland China and from under developed countries like India, Pakistan, and many parts of Africa. Apart from the low rental level, the underprivileged choose to live in them mostly because of their convenient urban location. The population of the people who live below the poverty line in Hong Kong is currently estimated of 1.25 million, and the population that lives in the poorest condition of Cage Homes and Cubical Flats are more than 100,000.⁴⁹

48 "CNN News Story about Cage Homes in Hong Kong." YouTube video, 2:47. Posted by "mcsjacob00001," October 29, 2009. <http://www.youtube.com/watch?v=D5hlf2RYdY0>.

49 Hong Kong Stories. "Living below the Poverty Line: Cage Homes and Cubical Flats." Online video, 2:31. Posted by Zoe Yiu, March 15, 2010. <http://www.hkstories.net/jmsc0007spring10/2010/03/poverty-sham-shui-po/>.

Close to home

It is impossible for us to solve the problem of the extreme disparity between the rich and the poor in Hong Kong, but we should be able to improve the living conditions of the underprivileged group. The attention should be focus on providing more Public Housing in a faster pace. Making a new town in the New Territories, rezoning an industrial area and erecting new housing estates on a newly reclaimed land at the outlying islands, all these methods can definitely mitigate the housing shortage. However the beneficial groups will not necessarily be the group that lives below the poverty line, most of them are unwilling to leave their older town for many reasons. Those employed locally that they don't want to travel the extra mile and also cannot afford to pay the extra transportation cost. The elderly do not want to be separated from their social group. Furthermore, the newer towns cannot compete with the low living cost that older towns offer. Sham Shui Po market for example, sells their groceries at an unmatched price. Improving the living condition for the poorest without rehousing them distance away from their original habitat becomes the most suitable redevelopment solution. If this can be achieved, the poor living condition in these older towns will also disappeared and the cage homes and cubical flats can also be demolished.

However, there is one condition that needs to be solved. This is that is the remote or less accessible location of the Interim Housings is too inconvenient for relocating the existing residents of redevelopment projects. If temporary housing can be provided locally near the redevelopment project, acquisition can be much easier and city renewal can be achieved in a quicker pace. Possibly the waiting time for the Public Housing qualifiers can be reduced. Disqualifiers like the sandwich class may also be benefited when there are more housing productions, the eligibility for Public Housing may eventually be adjusted down. Part from creating more housing, older towns will be renewed, recycled, rebuilt, regenerated and revitalized into more sustainable new towns in terms of economic, social and environmental aspects.

Problematic old towns



Fig 14. The poor living condition of the old town. Video.

Source: <http://www.hkstories.net/jmsc0007spring10/2010/03/poverty-sham-shui-po/>.



Fig 15. ICC Building with the luxury housings, and the Yau Ma Tei old town behind. Photograph.

Source: <http://birthofawine.blogspot.co.nz/2012/06/not-all-beer-skittles.html>.

Hong Kong's economic grows rapidly in the past decades and so as its new developments. Disregarding the redevelopment of the aging older towns deep within the inner city, new land was expanded out towards the harbour by reclamation. The vast majority of these new lands consist of high-rise buildings, with nothing recently built shorter than 40 stories. According to Emporis (A worldwide leading database for building information) Hong Kong has the world's greatest number of skyscrapers at 1,308 and the greatest number of high-rise at 6,588.⁵⁰ The tallest in Hong Kong and the world's 5th tallest building is the 484m high International Commerce Centre (ICC). This building is one of many that are located on Hong Kong's reclaimed land. Alongside are the series of luxury housing estates built by private real estate developers. These high-rises are built in uniform height with minimal space in between. They shut out the sea views of the inter Yau Ma Tei old town, also reduces the airflow that come from the harbour. The rise of this city phenomenon was caused by "the closing of the city airport in 1997 and the consequent removal of the height limit without restriction, except that of plot ratio, and without a great deal of thought as to what real estate developers would make of this literally golden opportunity, resulted in environmental destruction on a grand scale."⁵¹ The older towns were predominantly built under the height limit when the Kai Tak Airport still operating, there are little open spaces, tight streets, pack-together buildings and heavy traffic. The already unhealthy towns get worst with the newer taller building screening off the incoming airflow, the air circulation becomes difficult and leads to the intensification of the heat effect. This increases humidity, and aggravates air pollution with in turn affects the public health. This climate impact is commonly known as the 'wall effect'⁵².

50 Emporis. "Hong Kong: Buildings." Accessed June 8, 2012. <http://www.emporis.com/city/hongkong-china>.

51 Edward Ng, ed. *Design High-Density Cities for Social and Environmental Sustainability*. (London: Earthscan, 2010), p.19.

52 Wikipedia, s.v. "Ecology of Hong Kong." Accessed September 14, 2011. http://en.wikipedia.org/wiki/Ecology_of_Hong_Kong#.22Wall_effect.22.

The 'urban heat island phenomenon'⁵³ is another factor that impacts on the climate of Hong Kong's urban area dramatically. The materials used on the modern fabric such as steel, concrete and glass attracts heat and traps it in. Without sufficient air circulation the heat is retained in the urban areas and released at nighttime, which makes the urban areas always has few degree higher than their surrounding rural areas. The urban heat island effect can be mitigated through the use of city greening and surface material with lighter-colored that reflect more sunlight and absorb less heat.

The next problem is an aesthetic issue. The system of vertical living has disconnected the residents from the external fabric of the building. The façade of a building becomes a place dedicating for services such as piping for plumbing, air-condition units and clotheslines. They are not merely eyesore but also hazardous with exposed piping that creates paths for rats and burglars to climb. Hanging the washing out the window can be dangerous in that clothing, hangers and clothes pegs may fall off the clotheslines.



Fig 16. Hong Kong's common wall of buildings. Photograph.

Suroce: The Telegraph. "A Housing Estate in Hong Kong, China." The Week in Pictures: September 6, 2008. <http://www.telegraph.co.uk/news/picturegalleries/theweekinpictures/2690758/The-week-in-pictures-6-September-2008.html>.

53 "Greening the Building façade in Singapore." Online video, Asia Pacific Lohas. 9:42, Posted January 28, 2010. <http://www.lohas-asia.org/tag/green-facade/>.

Possibility for a new method

All methods will eventually create more land for Hong Kong's needs, and redevelopment of the older towns is the most appropriate method available for housing those people who need to be taking care of most. However even though the viability of urban renewal has been limited by many difficulties, I believe there is a possibility for a new, faster, more efficient and cost effective urban renewal remedy, without the requirement for new land such as by harbour reclamation. Lands have always been available deep within the city. This land is being underdeveloped, underutilized, underestimated, undervalued, and under the bridges.

The method of road widening is rarely the suitable option for the already developed inner city. Expansion or upgrade for traffic facilities has been predominately taken place skyward over pre-existing roads in a multi-layer scale. Flyovers, viaducts or overpasses, whilst all these vehicle bridges assist the arteries of the city in reducing traffic congestion, the tradeoff is the wasted space beneath. With the exception of small portion of spaces required at the abutments for the supporting piers to prop-up the bridge slabs, the majority of spaces beneath the traffic viaducts serve little purpose. The underneath spaces of these vehicular bridges can be easily utilized into housing. The government already owns them, and there is no demolition time as they are already empty. Under-bridge housing is not a fresh idea, but has not yet become a reality. Presumably it is the perception of the under-bridge spaces as negative, dark, filthy, dusty, and nosy that only the homeless would take shelter under. Due to all these sensational displeasures the concept of under-bridge habitation has not been accepted.



Fig 17. A flyover in Kowloon Bay with its underneath space unutilized. Photograph by author.

Wastage of available lands

With the limited amount of land in Hong Kong, appropriate utilization is required to cater for the densely populated city. However, large areas of land are being abandoned as wasteland all over in the urban area. Under-bridge spaces have always been seen as a void that cannot offer much practical function. The government believes that they have found the purpose for these spaces, which they extensively filled with greening and landscape for almost every smaller inhabitable under-bridge space. It seems to be the most appropriate application in that it can soften the harshness of the super structures and also help to neutralize the polluted air. Public open spaces such as parks and playgrounds also are an appropriate use for under-bridge spaces. They don't require a lot of headroom, and hence free up other prime land for high-rise development.



Fig 18. Hoi Shing Garden in Tsuen Wan under motorway flyover.
Photograph by author.

However, these should not be the only solution. Hoi Shing Garden in Tsuen Wan is an example of a misplaced park. Over two hours of observation in a present weekday afternoon, the nicely landscaped park with a lots of seating only had about five people walked through it and not one person actually stopped and used it. It is most definitely a planning error in that it is situated in the industrial area, which was barely used during lunch breaks. Furthermore, flyovers are usually used as transport highways that can run for miles. Parks and playgrounds only require a small portion of its length. Therefore, an abundance of leftover land is still available where many government departments made use of these spaces as their offices, vehicle depots and storages. Indeed, these government offices are nothing fancy, nothing architectural, just simple temporary looking containers or container like constructions. Currently, there are many more facilities that can be found under the bridges of Hong Kong. For transportation purpose there are bus terminals, tram stations, taxi stands and most commonly car parks. For the public facilities, there are public toilets, parks, playground and recreations. As for private businesses, there are gas stations, newspaper and magazine stands, and recycling merchants.

Apart from landscape, all other under-bridge elements are seem to be lacking of design in terms of aesthetic consideration, with design intention predominately a product of their function. Steel net and corrugated steel fencing is merely the most economical spatial and visual barriers. Solid concrete and steel container structures feel no different to our ordinary garden shed. Their standalone characteristic brings out temporariness that has no sense of belonging, no visual or spatial connection to their super structure above, and definitely not architecturally pleasing. It may all make sense if we believe that Hong Kong's under-bridge spaces are all busily occupied, however in reality a large amount of these spaces are left vacant and fenced off. They are there, and available for utilization and possibly a great architectural opportunity.



• **Storage**



• **Greening**



• **Bus Terminal**



• **Car parking**



• **Sport ground**



• **Gas Station**



• **Park/Playground**



• **Public toilet**



• **Temporary Market**

Fig 19. The Current uses of under-bridge spaces.
Photograph by author.

The hypothesis

Redevelopment is possibly the most sustainable method to utilize land use, and unquestionably the only method for creating more livable space in the already developed urban area. As discussed earlier, one of the most vulnerable holdups that disable residential redevelopment is the temporary relocation of the existing inhabitants. The current solution of interim housing program is not very effective due to their remote locations. Hence if temporary accommodation can be provided locally, the redevelopment becomes a more feasible option. Unfortunately, the chance for the local public housing estate having enough available units for temporary accommodation is unrealistic. Vacant lands such as demolished factory sites are still occasionally available within the city. They will eventually be redeveloped either by the government or private developers. Therefore, these lands will unlikely be used for temporary housing as temporary housing usually has an indefinite timeframe and difficult to get rid of. The government cannot risk any holdup to future redevelopment of these prime lands that may cause by temporary housing. Therefore, the only 'free' lands readily available are the underutilized under-bridge spaces. These unnoticeable spaces can be found in every developed parts of the city due to the shortsighted planning over the years that has left behind plentiful of elevated traffic infrastructures. It is time for these overpowered structures to contribute to the city a bit more than they were originally designed for.



Fig 20. Under-bridge space is common home for the homeless. Photograph by author.

Questions may be asked here about the interim housing over the permanent public housing. Since the deteriorated image of under-bridge buildings were caused by their unaesthetic approach, proving that people do judge things by their appearances. Buckminster Fuller (1895-1983) said: "When I am working on a problem I never think about beauty. I only think about how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong." Under-bridge living will require both a lot of effort and good design solution to convince the public and the government of the worth of this idea. Interim housing only provide living quarter in a temporary term, which make it easier to be accepted comparing with the paramagnet situation. In addition, a well-designed interim housing project will prove the habitability of under-bridge spaces and lead the way to changes public's view over time. It can also be treated as the experiment for the future permanent under-bridge living when the city's land resource cannot be achieved elsewhere. But for now, interim housing has a more suitable role to play. Immediate attention should be given to the renewal of the older towns for better urban planning, more housing and improved living conditions. Employing interim housing into the under-bridge spaces will become the key to keep the redevelopment of the city rolling, and redevelopment is not a long-term goal but a sustainable ongoing act that will never stop because there will always be outdated buildings.

This explanatory document suggests the interim housing should be in the form of a portable modular system, thus allowing them to be easily transported from site to site. The concept is similar to container offices that can be move from job to job. By providing the temporary relocation as near to the redevelopment as possible, the impact of the everyday living routine of the residents is deem to be kept at a minimal scale. Assisting the city renewal with Interim housing is a more holistic approach. In contrast, putting permanent housing under bridges will eventually used up all these spaces and the problem of city decaying will still be here.

Precedents of under-bridge architecture

In Hong Kong, there is only one current example that can be classified as under-bridge architecture: the Hong Kong Federation of Women T.S. Kwok Service Centre designed by Barrie Ho⁵⁴. This is situated beneath the Canal Road flyover, recognized as the boundary between Wanchai and Causeway Bay. The visual fragment between the two districts was once further emphasized on the street level by the unpleasantness of the former centre, which was often mistaken as a public toilet. Public perception of the building changed when it was redeveloped, with the extensive use of glass panels in the new design leading to a visual transparency enabling the internal spaces and the street to be more connected to each other. The torn urban fabrics are also stitched back together creating a more fluent and dynamic streetscape. Ho's design is a break through from the old conventional approaches to under-bridge spaces. It is a role model that sets out a new horizon for looking into the utilizations of Hong Kong's valuable land. In his words "I hope that this project could serve as a case study demonstrating the plasticity of leftover spaces in Hong Kong. With a relatively unconventional approach of creative revitalization, it is hoped that some of the land use issues specific to Hong Kong could be alleviated."⁵⁵



Fig 21. Hong Kong Federation of Women T.S. Kwok Service Centre. Photograph.

Source: <http://www.archdaily.com/130190/the-hong-kong-federation-of-women-t-s-kwok-service-centre-barrie-ho/>.

54 World Architecture News "Hong Kong Federation of Woman T.S. Kwok Service Centre, Lockhart Road, Wanchai, Hong Kong." Posted June 30, 2011. http://www.worldarchitecturenews.com/index.php?fuseaction=wanappln.projectview&upload_id=16982.

55 Arch Daily. "The Hong Kong Federation of Woman T.S. Kwok Service Centre / Barrie Ho." April 25, 2011. Accessed January 12, 2012. <http://www.archdaily.com/130190/the-hong-kong-federation-of-women-t-s-kwok-service-centre-barrie-ho/>

Apart from Hong Kong, under-bridge architecture examples are only rarely found in rest of the world. In Zurich, Switzerland the local architectural firm EM2N won the design competition for recreating the stonemason arches viaduct in 2004. The project name 'IM VIADUKT'⁵⁶ was aiming to reconnect the parts of the city back together, which were long separated by the original railway line viaduct into a residential area on one side and industrial on the other. The new concept was to infill the 53 arches of the viaduct with shops and cafes, a market hall into the triangular space created by the separation of the two railway lines, an elevated pedestrian and bicycle path transformed from the retired lower level of the two railway lines. Now this 500-meter long shop strip brings in people and vitalizes the area. The viaduct has not just had a 'face-lift', but this spatial barrier from 1894 is also transformed into a connecting structural element suitable for everyday use.



Fig 22. IM VIADUKT. Photograph. Source: <http://www.im-viadukt.ch/content/bilder>.

56 Claudia Fuchs. "Market Hall and Shops Im Viadukt in Zurich." Detail. Online Magazine. October 2011. <http://www.detail-online.com/architecture/topics/market-hall-and-shops-im-viadukt-in-zurich-006649.html>.

Another good example is the motorway bridge and control centre project in Nanterre, Hauts-de-Seine in France⁵⁷. Designed by Odile Decq and Benoît Cornette, the motorway project includes a section of viaduct consisting of two separate carriageways traveling in opposite directions and supported by seven structural bays for a total length of 250m. Underneath are buildings making up the Motorway Management Centre and used for various functions. The bridge itself is a simple dynamic streamlined structure, and the control centre with horizontal sunshade and its sloped facades emphasize the sense of dynamism in a coherent way, where the bridge and the control centre works as an entity representing one work of architecture. This was not an after-thought in spatial use but a consideration use from the beginning, and is exactly how we should plan and design our city today. While designing a flyover, the utilization of its underneath spaces should also be careful considered at the same time and avoid the waste of space that becomes the non-functional. If all bridges in Hong Kong were built based on this design philosophy that there would have not been so much wasteful spaces in our urban environment today, and my proposal would not have to exist.

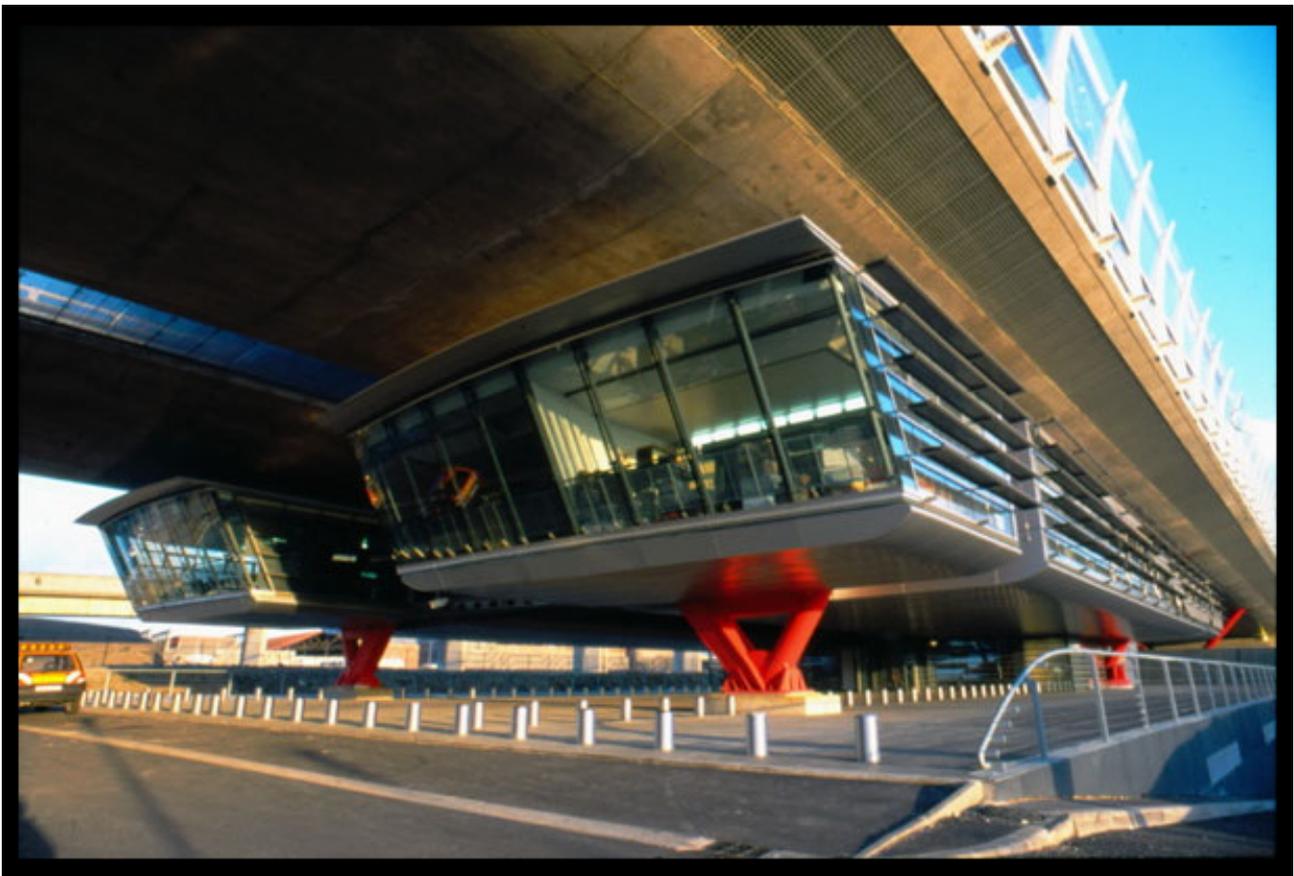


Fig 23. Motorway bridge and control center, Nanterre, France. Photograph.

Source: http://www.odbc-paris.com/EN-22-project-74-Motorway_bridge_and_control_center_Nanterre_France_Nanterre.

57 “The Project Motorway Bridge and Control Center for Autoroute 14 Nanterre.” Floornature. Posted May 24, 2004. <http://www.floornature.com/projects-infrastructure/project-motorway-bridge-and-control-centre-for-autoroute-14-nanterre-4379/>.

Legal restrictions

As far as the Hong Kong government concerns, the use of all under-bridge space should comply to Section 7 'Use of Land Beneath Flyovers and Footbridges' of 'Chapter 12: Miscellaneous Planning Standards & Guidelines'⁵⁸ of the "Hong Kong Planning Standards & Guidelines". The number one condition is as follows; "Flyover/footbridges sites should only be considered as alternative solution space for uses upon exhausting all other suitable sites," which it is perfectly matched by this aim of this proposal that locations for local interim housing cannot be sought anywhere else other than under-bridge spaces. Secondly, greening and landscape is strongly encouraged to be integrated to any particular under-bridge usage, therefore, the polluted motorway air can be filtrated and the visual impact created by the massiveness of the super structures can also be softened substantially. Thirdly, for a more coordinated result, early consideration of the potential uses for the underneath spaces should be specified at the initial at planning stage. However, good examples of the pre-specified under-bridge usages are merely few parks and landscapes, others are structures that are crudely put together and show no visual appreciation. The idea of integrated under-bridge spaces has never been solely achieved.

Restrictions of the use of under-bridge spaces that concern this particular project

Structural –

- New buildings must be structurally isolated from all bridge structure. This includes columns, bridge decks and soffits.
- The use of a crane is prohibited unless otherwise agreed by the Highways Department or Building Department.
- New buildings must not interfere to the use of adjacent road in terms of access, sight and signage.
- New buildings must leave sufficient clearance spaces between bridge structures to allow for any inspection and maintenance that may need to be undertaken.
- The drainage system of the bridge should not be affected in anyway.

Fire Safety –

- Storage of inflammable products that have a high level of fire risk may not be permitted.
- New building must comply with the fire safety requirements laid down by the Fire Service Department and Buildings Department.

Traffic –

- New building's usage must not cause undesirable problem to the nearby traffic, such as increasing the risk of traffic congestion.
- Site access must be carefully designed for avoiding the obstruction of the ongoing traffic on the adjacent roads.
- Traffic flow and conditions of the adjacent roads should be taken into account when designing the pedestrian and emergency access.

⁵⁸ "Section 7, Chapter 12: Miscellaneous Planning Standards and Guidelines." Planning Department. Last revision date: November 2008. http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch12/ch12_text.htm.

Environmental –

- Building usage that allows users to be exposed to unacceptable environment conditions for prolonged periods should be avoided.
- Provision and management of air/noise/odour pollutions should be provided where necessary.
- Appropriate air ventilation systems with fresh air intakes should be provided where necessary.
- Airflow obstruction through the site should be minimized.

Besides the considerations and the restrictions of the use of under-bridge spaces, there also is a predetermined list that indicates the uses, which are acceptable, conditionally acceptable and unacceptable for under-bridge spaces. Many listed unacceptable uses are related to the issues of hygiene, health and safety. One such example would be a restaurant space that, due to its activity, increases the risk of fire. Another example would be a hospital that needs the highest-level hygienic environment, or active outdoor recreation spaces where people may suffer from the polluted air. Residential uses are also not acceptable. However, the acceptance of the listed unacceptable uses are bound to be alternatively negotiable upon the conditions of context and design, since there are restaurants already taken place under the bridges, and basketball courts do exist beneath flyovers. In addition, the acceptability can also be moderated when the usage is merely temporary. A permanent market place is not acceptable but a temporary market place is. In that sense, permanent housing will not be approved but a temporary housing will.



Fig 24. Food stalls at the under-bridge Haiphong Temporary Market. Photograph.

Source: Derrick Chang. <http://www.cnngo.com/hong-kong/play/what-lurks-under-bridges-hong-kong-679481>.

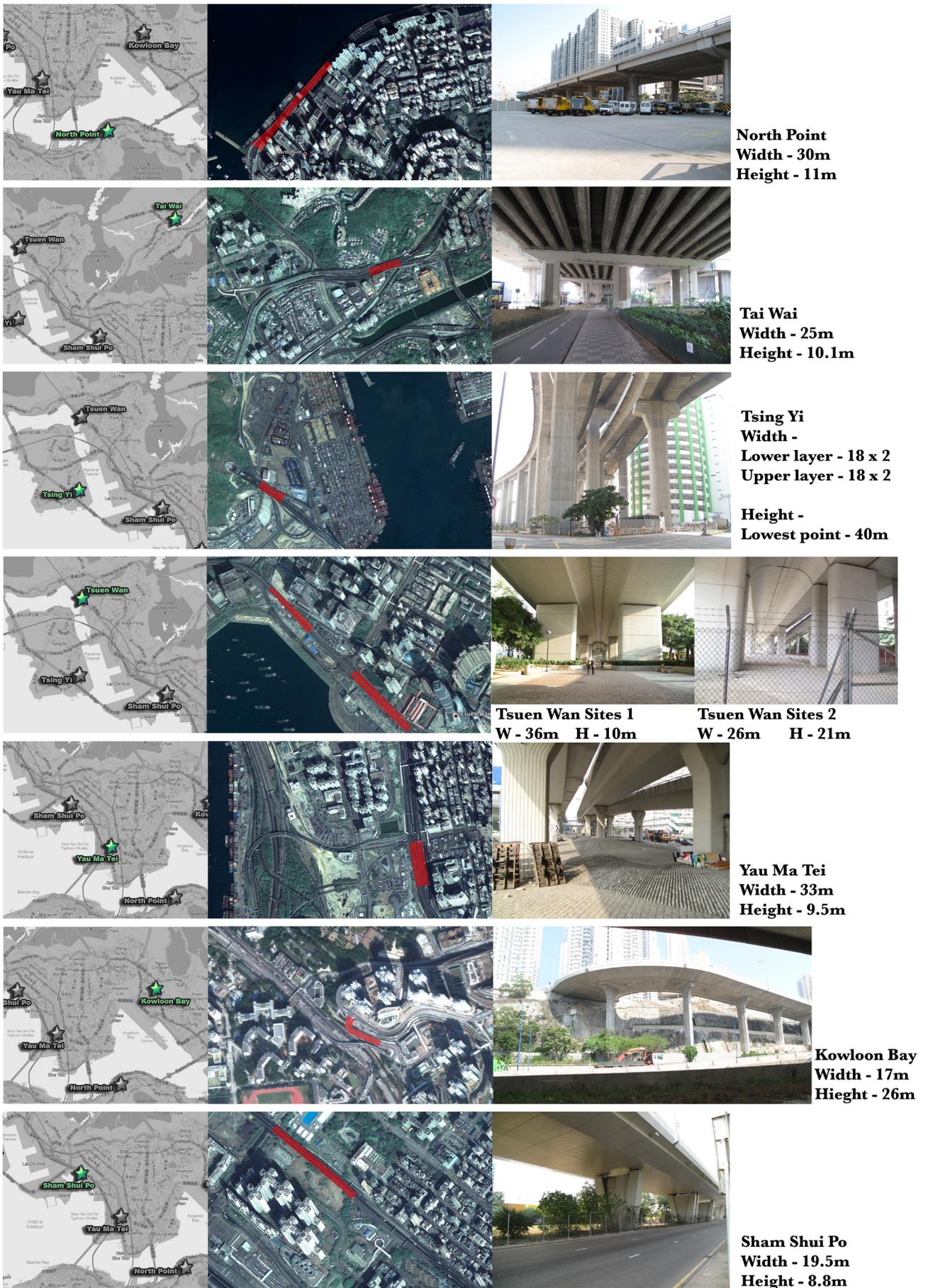


Fig 25. The 8 potential sites. Photographs and illustrations by author.

Generic issues

At the beginning of the research, eight potential sites in different parts of Hong Kong were chosen to be analyzed and observed: Tsing Yi, Tai Wai, North Point, Sham Shui Po, Kolwoon Bay, Yaumatei, and two sites under the same motorway bridge of Tsuen Wan on two different sections. However, the specific analysis of each site conducted earlier has become less important as the core of the proposal has been shifted from site specific to site generic. Based on the proposal of the housing system that it should be flexible enough to fit under the majority of under-bridge spaces, the generic analysis of under-bridge spaces became the most significant factor. Under-bridge spaces basically is a boundary predefined void that differs from an ordinary site that only has the boundary in two directions: the width and the depth, and the height limitation in Hong Kong is the typically the sky. Under-bridge sites have limited exposure to the sky. They are often cast in shadow, with perhaps a slit of light between two carriageways if lucky. Maximizing the use of natural lighting would predominately restrict the two elongated sides of the adjacent roads. The second challenge is to design around the structural columns. Despite the regulation of the clearance spaces required for inspection, these structural elements align in a regular pattern and their large physical mass can obstruct the horizontal circulation from bay to bay. Therefore the design layout would be significantly influenced and restricted by these structural elements. Other common issues are the environmental impacts. Firstly, low frequency noise due to moving vehicles that cause oscillations of the movement joints in the bridge structures, as well as surface noise generated by car tires. Secondly, vehicle exhaust fumes from the above bridges and adjacent roads. Furthermore, The issues of dust and odour should also be taken into account.

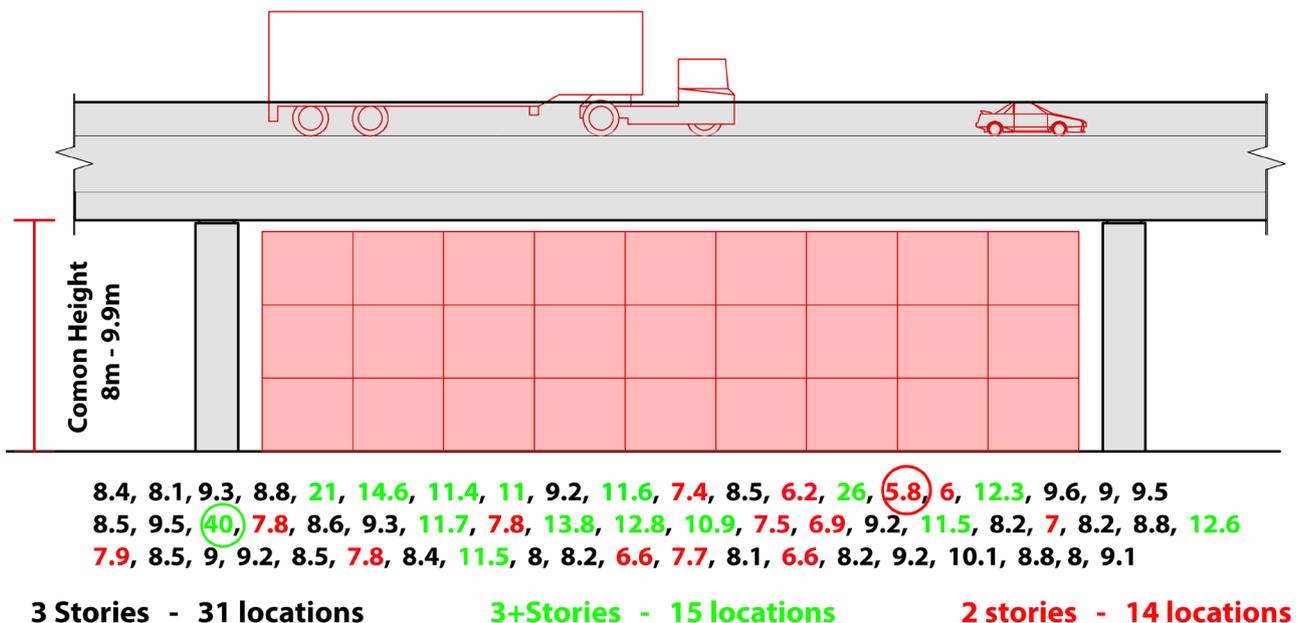


Fig 26. Random headroom measurements of under-bridge spaces in Hong Kong. Illustration by author.

Varied issues

In order to design a universal plug-in housing system for the under-bridge spaces, the most important data that needs to be obtained is the average height of under-bridge spaces in Hong Kong. Therefore, a total of 60 headroom (height) measurements were recorded from the randomly selected locations with a laser distance measurer, and the typical figure is between eight and nine meters. Consequently, the design needs to focus on providing housing that will be most suitable for a three level configuration. It should also have the ability to adapt in locations with less or greater headroom. As bridge widths are variable, so any design would have to incorporate apartments units capable of variable depths, so as to suit the variety of bridge types available.

Sham Shui Po the utopia (site)

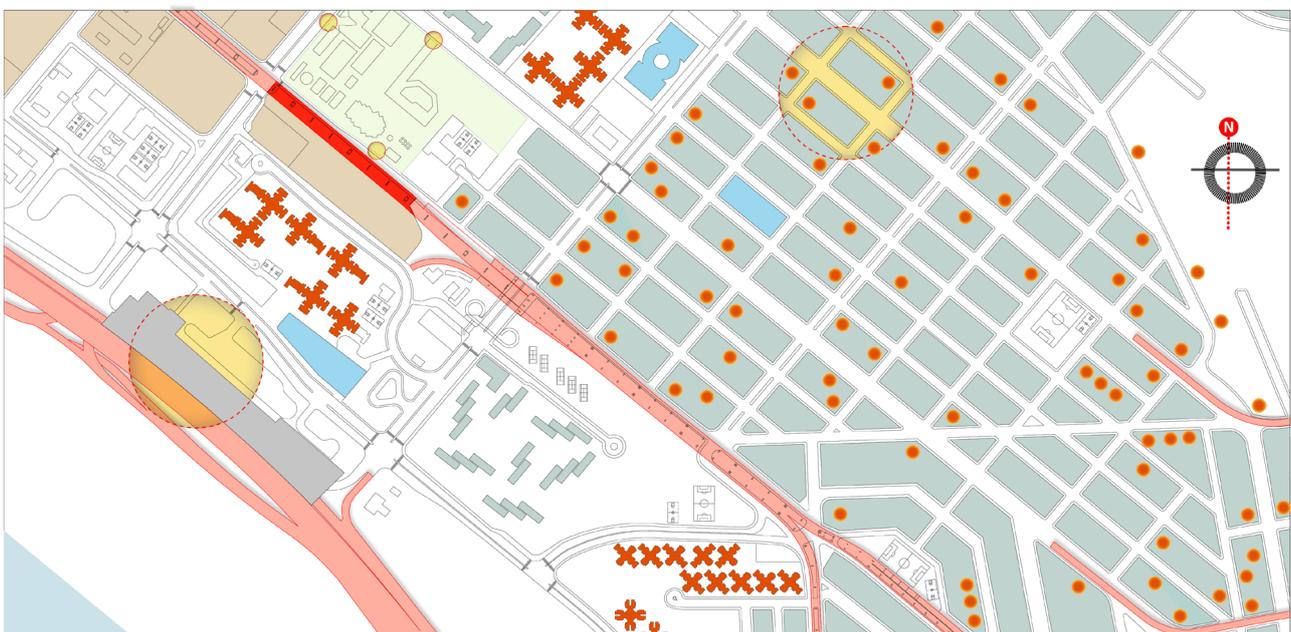
The proposal intends to be a generic approach to under-bridge spaces. Hence a specific site is not required. This particular site is nominated to demonstrate the feasibility of the proposed system and how it can adapt to a certain site. As the system has to be flexible enough to slot into the majority of under-bridge spaces, the contributing factor for the site decision is not based on its conditions or its context, but the current social and developmental status of the area that it is situating in. Sham Shui Po⁵⁹ is one of the earliest developed urban district in Hong Kong. It was once a central hub for commerce, industry and transportation. Now it is a graveyard of old buildings, considered by many as the most ruined and decayed urban area in the territory. This district resides the poorest inhabitants with the lowest median household incomes; and on average the oldest population, with new immigrants from the Mainland China and many other under-developed countries making up many of the residents. Many of the people here are living in cage homes and cubical flats, substandard accommodation. The Hong Kong Housing Society announced the first urban renewal project in July 2003 for improving the living condition of Sham Shui Po with the redevelopments of the aged buildings.



Fig 27. The view of dilapidated Sham Shui Po. Photographs.

Source: <http://500px.com/photo/7521562>.

Due to all kinds of difficulties the renewal program is being carried out in a relatively slow pace. The most ideal re-planning of the area is to replace all the closely packed apartment blocks with private/public housing estates. With taller forty plus stories buildings, it will free up a decent amount of surface land for passive open spaces and wider roads. "Perhaps it is not the space within building envelopes that matters. It is the spaces in between buildings that test the design of high-density cities."⁶⁰ The reforming of the city layout into housing estates will eventually mitigate the microclimate of the area. It will increase airflow and the use of natural day light. Air pollution and unpleasant humidity will also be diminished. This unattractive district of Hong Kong will be gradually improved and eventually transformed to the future model of urban development. It is beyond the scope of this proposal to deal with the city planning or designing housing estates. The core of this proposal will offer the opportunity for the ugliness of the city to become more beautiful, and create an opportunity for a much delightful and vibrant under-bridge spaces that blends into the cityscape.



Site: Sham Shui Po, Hong Kong

- **Site**
- **Vacant Land**
- **Newer Housing Estate**
- **Older Housing Estate & Apartment**
- **Main Retail**
- **Highway & Overpass**
- **Transportation Hub**
- **Redeveloped Site**

Fig 28. Sham Shui Po site. Illustration by author.

60 Ng, ed. *Design High-Density Cities for Social and Environmental Sustainability*. P. XXXiii.

Design methodology

Like many public housing programs, the under-bridge interim housing would be a heavily subsidized scheme. It is designed for residents who are willing to swap their current properties for redeveloped flats through the FFF scheme. It is also for the local residents who are current renting but eligible for permanent public housing flats on the waiting list. If the facility is large enough that it can also accommodate the people who have urgent needs from any parts of the city. As a temporary housing scheme the focus is on providing necessity and not luxury. Economical cost needs to become one of the core principles that drives all design consideration related to construction. The proposal will work in with the city renewal scheme as long as it needs to be, but occupants in these temporary homes moving in and out these flats roughly every three years period (the 'three years' estimation is based on the current construction time for a redevelopment project. They usually take approximately three years to complete and such time is anticipating to be reduced by government's commitment). Therefore the durability of housing must be reasonably long-lasting that it reduces the maintenance cost and running cost. Besides the cost, economy of space is also equally essential. The more flats that an under-bridge housing can accommodate, the bigger redevelopment project it can support. Residents will occupy living spaces considered as 'just sufficient', with the design focusing on capacity, compactness and functionality of internal spaces.

The under-bridge interim housing design proposal consists of two major parts: standard components and specific components. Standard components are the elements that consist of portable flats that can be transported from site to site. To make transportation and manufacturing easier, each flat consists of several standardized modular that are small enough to put on the back of trucks, and light enough to be unloaded and assembled on site by medium/light weight machinery. Constructions and manufacturing work will predominately be prefabricated offsite. "The primary purpose of prefabrication is to produce building components in an efficient working environment with access to specialized skills and equipment in order to reduce cost and time expenditures when assembled on site, while enhancing quality and consistency."⁶¹ In terms of structure, each modular is designed to be self-supporting in a stacking system much alike shipping containers. One open outlook window and vented entrance will be provided for each flat that allows natural cross ventilation for tenant's occasional use. However the primary air treatment will be dependent on mechanical air-handling system that does the filtering and cooling for the internal comfort. In order to achieve energy efficiency that all flats are required to be reasonably airtight, in addition to airtightness that it will also prevent dust and odour entering, improve thermal insulation, and reduce the noise level. All services should be hidden and away from the façade so that the exterior appearance can be kept in a pure aesthetic state. To reduce on site work for electrical and telecommunication wiring, plumbing for water supply and drainage, services will be pre-installed within the portable units. So they only need to be plugged on site with an umbilical cord system.

61 Mark Anderson, and Peter Anderson. *Prefab Prototypes: Site-specific Design for Offsite Construction*. (New York: Princeton Architectural Press, 2007), p. 7.

The secondary design elements are the specific components, which are the parts that make up the circulation, open spaces and common spaces. Design and specification can be varied from site to site as determined by site conditions including width and height of the bridges, the number of carriageways, bridge slab span and site accessibility. Other considerations include the status of context such as adjacent roads, traffic flow, nearby buildings and facilities, as well as climatically factors like sun, orientation and prevalent wind directions. Here are the keywords that will sum up the whole design methodology: prefabrication, portability, low-cost, capacity, compact, functionality, durability, energy-efficient and eco-friendly. Essentially, the core issue has always been the finding of balance between quality and quantity (how to justify the size of the living spaces).



Fig 29. West Kowloon Corridor and its beneath space. Photograph by author.



Fig 30. Looking into site from the Tonkin Street end. Photograph by author.

Design Program

The Sham Shui Po site is beneath a section of the motorway call West Kowloon Corridor that runs between Tonkin street and Yen Chow street. The width of the four-lanes flyover is 20 meters and the height of the under-bridge spaces measure in an average of 8.8 meters, which allows sufficient space for three level structures. Like all other public housing estate that the ground level is not for residential use due to hygiene, security and privacy issues. Instead the street level is commonly used for commercial purposes, and revenue can be generated through retail leasing which recovers the cheap subsidized housing rental. Another common source of financial income for public housing comes from car parking. For this particular site extra car parking is not needed due to provision already existing on the adjacent public housing Fu Cheong Estate. There is another parking area right next to the site under the same bridge. In this case therefore the street level usage for this proposal could be for mini storage rental, since inadequate storage space is a very common problem for almost every household of Hong Kong. The housing units are typically very compact, and installed with built-in furniture. Although there will also be built-in storage that may satisfy some residents, those who already own furniture and have too much personal belongs may chose to pack away in the mini storage temporarily until they move into their permanent flat. The storage units are also available for the public to use. As bicycles are highly encouraged in today's sustainable town planning, the redevelopment of the town should also include bicycle lanes along with the future road widening. On the street level of the under-bridge housing that there will hence also be bicycle lockups and bicycle rental for promoting a greener environment. There may even be an 'urban greenway'⁶² together with Sham Shui Po's artificial coastline that can be linked to the mega West Kowloon Cultural District project, undertaking by the architects Foster + Partners. Other facilities that can also locate on the street level include office and administration for mini storage, loading areas, apartment entrances and foyers, and services control rooms.



Fig 31. Interim housing program. Illustration by author.

62 11. *Green Streets and Urban Greenways.* "Connect2 and Greenway Design Guide. Sustrans. Connect2 Resources. <http://www.sustrans.org.uk/what-we-do/connect2/connect2-resources>.

The first floor and second floor of the complex are the main body that contains the housing flats. There will be three flat size options. First the smallest studio type for the single person or elderly who lives alone. Then the one-bed room flat for couple or small families. Last is the two-bed flat for bigger families. The design proposal propose that the first floor will hold a fixed number of one-bed and two-bed flats while the second floor contains all flat sizes, interchangeable to suit particular occupants' needs. Main circulation spaces for lifts and stairs are located around the bridge columns. The proposal includes common open space and playing areas for kids. Since major spaces on the horizontal planes are devoted for people, greenery will occupy the vertical planes among the façade.

The H.I.V.E system

This acronym stands for 'Hexagonal Inhabitation & Various Exigency'. The name bears the similar meaning to the word "hive" as the original word 'hive'⁶³. According to Collins English Dictionary, is defined as "a structure in which social bees live and rear their young" or "a teeming crowd; multitude". It may also be used as a verb meaning, "often follow by up or away to store, especially for future use". The H.I.V.E system is a structure that is a development for living, it will be "swarmed" by people and a storage for people and their belongs in a temporary term.



Fig 32. The Hexagonal honeycomb. Photograph. Source: <http://nutters.edublogs.org/maths-in-nature/>.

63 *Collins English Dictionary*, s.v. "Hive." Accessed August 15, 2012. <http://www.collinsdictionary.com/dictionary/english/hive?showCookiePolicy=true>.

Portability and prefabrication

Although the system is purposely designed for the under-bridge housing, to make the production of the system even more economically sustainable it must be capable of doing more than one or two tasks in the future on the emergence of specifically designed plug-in components for specific functions. "From housing and emergency facilities to shops and schools it is now possible to envision mobile units equipped with every comfort and ready to fulfill nearly any function."⁶⁴ Mobility in dwelling system is not a new technology, and can be traced back to the Native American tipi tents, the wagon trains of the western gold-rush era, or the Volkswagen Kombi van. Mobility (portability) in architecture began and has always been associated with prefabrication ever since, especially when low-cost, efficiency and precision can be achieved through mass production techniques. Major architects around the globe Le Corbusier, Jean Prouve, Walter Gropius, Buckminster Fuller, Frank Lloyd Wright, Richard Neutra, Charles and Ray Eames, and Mies van der Rohe all got involved with prefabricated building. "The element that unites their work is the concept of employing basic reusable modules that can be expanded as desired."⁶⁵

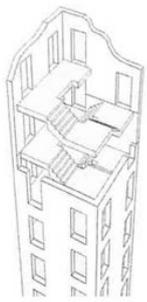
There are three precedents in portable architecture that were exceptionally important along the process of this design proposal. Firstly, the 'Nakagin Capsule Tower,'⁶⁶ now demolished, but in 1970s' in Japan it represented the icon of modern living in small compact spaces. It is similar to this project in that it is a multi-modular prefabricated system in a large scale and within an urban setting. Each modular provides 10 m² of living space, which is pre-assembled with furniture and equipment in the factory before transported by truck and up-lifted by crane on site. Everything was custom built, including bathroom, storage and bed. "The project has become a symbol of interchangeable, recyclable and sustainable architecture."⁶⁷

64 Donato Nappo, and Stefania Vairelli. *Homes on the Move: Mobile Architecture = Mobile Architecture*. (Germany: h.f. ullmann, 2010), p. 11.

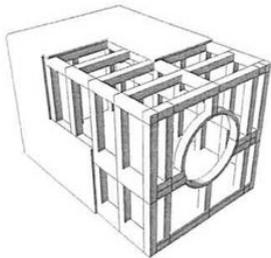
65 Ibid. Pp 16, 17.

66 Ibid. Pp 52-55.

67 Ibid. Pp 52.

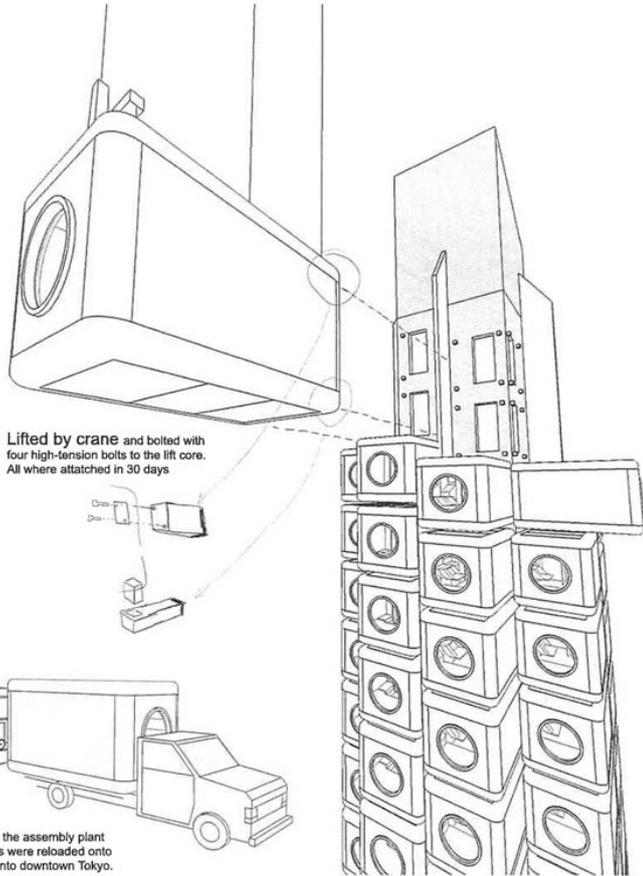
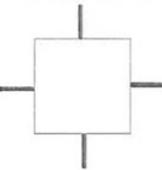
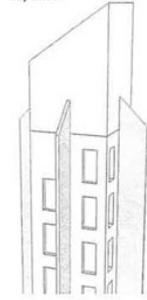


The lift shafts are circled by spiral staircases linking the many staggered levels. Constructed of precast reinforced concrete, the stairs were useable soon after each floor was installed and included components for the running of the lifts, reducing build

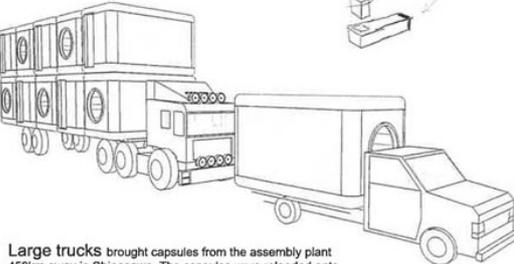


The capsules were prefabricated in a shipping container factory. They are welded lightweight steel-truss boxes. Clad with galvanised ribbed steel panels, a coat of rust prevention paint and a glossy spray of kenitex. (an impervious weatherproof plastic with estimated 20 year life span)

Service risers are in fact exterior fins on the lift shafts, concealed by the attached capsules.



Lifted by crane and bolted with four high-tension bolts to the lift core. All were attached in 30 days



Large trucks brought capsules from the assembly plant 450km away in Shinagawa. The capsules were reloaded onto smaller trucks before weaving their way into downtown Tokyo.

Fabricated Metabolism

A theory of constant mobility and change in the built environment.

Nakagin Capsule Tower, Tokyo

Fig 33. Illustrations of the Nakagin Capsule Tower.
Source: <http://architectureyp.blogspot.co.nz/2011/05/nagakin-capsule-tower.html>.



Fig 34 & 35. Nakagin Capsule Tower. Photograph.
Source: <http://www.arcspace.com/architects/kurokawa/nakagin/nakagin.html>.

The second influence has come from the 'Zip-up enclosures Nos. 1 and 2'⁶⁸ by Richard and Su Rogers. This is a totally configurable system that has the ability to expand upon users' wish. The wall, floor and roof are prefabricated in the factory and shipped on site for assembly into a structural ring that can be "zip up" with other rings in order to create a bigger space to cater bigger families. The wall, floor and roof components can also be customized in various look, such as colour and texture, or even altered to fenestration. The housing system can be located on almost any topographic contours with its adjustable steel jack stilts that largely increase its site adaptability. Therefore, mobility can be significantly increased and expensive concrete foundation is made redundant.

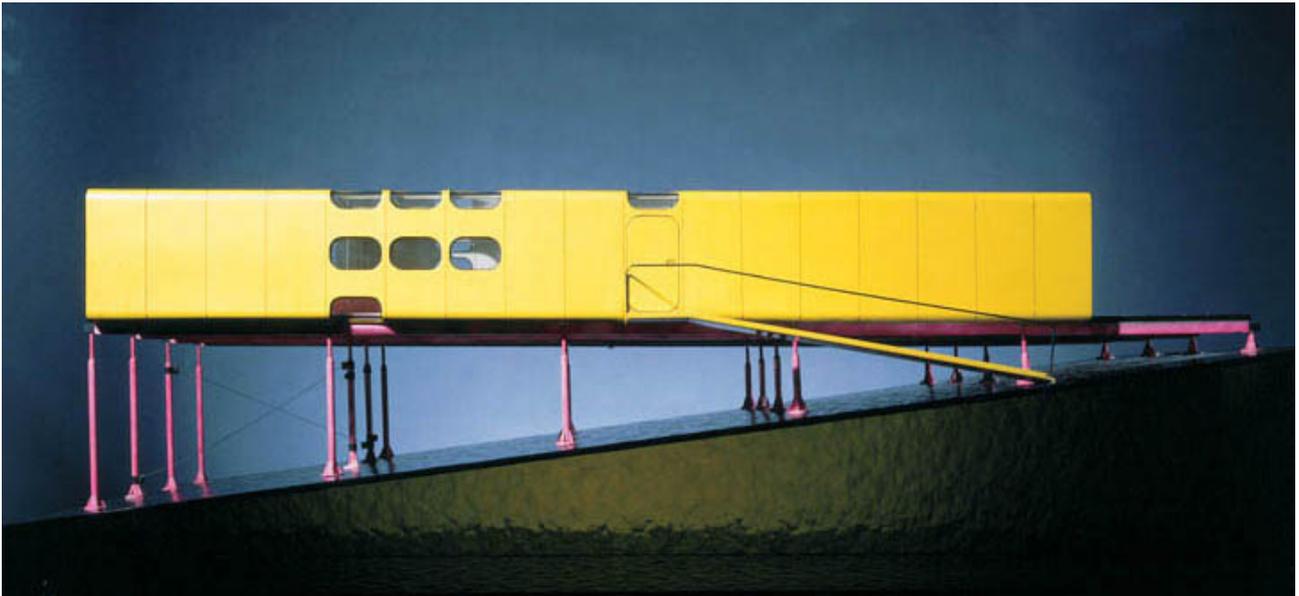


Fig 36. Model of the Zip-up enclosures and its adjustable steel jack stilts. Photograph.
Source: <http://www.seattlemodern.com/indexLA.htm>.

68 Barry Bergdoll, and Peter Christensen. *Home Delivery: Fabricating the Modern Dwelling*. Edited by Ron Broadhurst. (New York: Museum of Modern Art, 2008), pp148-51.

The last one is the 'Mobile Dwelling Unit'⁶⁹ (MDU) designed by LOT-EK. These self-contained compact flats are modified from shipping containers that can be transported from port to port on ISO truck bed and container ship. The standard size container has a series of push-out compartments that are used for sleeping, bathroom, kitchen, and storage facilities. A specially made service support frame is designed and located on port sites that allows the flats to be slotted in and out with the help of the specialized container handling machine. The H.I.V.E system shares many similarities with the above three examples, and these are the compact living and custom built-in of the Nakagin Capsule Tower, the expandability, interchangeable panel and site adaptability of the Zip-up, the logistic and site organization system of the MDU.



Fig 37. Mobile Design Unit. Photograph. Source: <http://dornob.com/40-foot-cargo-containers-into-stylish-small-home-spaces/?ref=search>

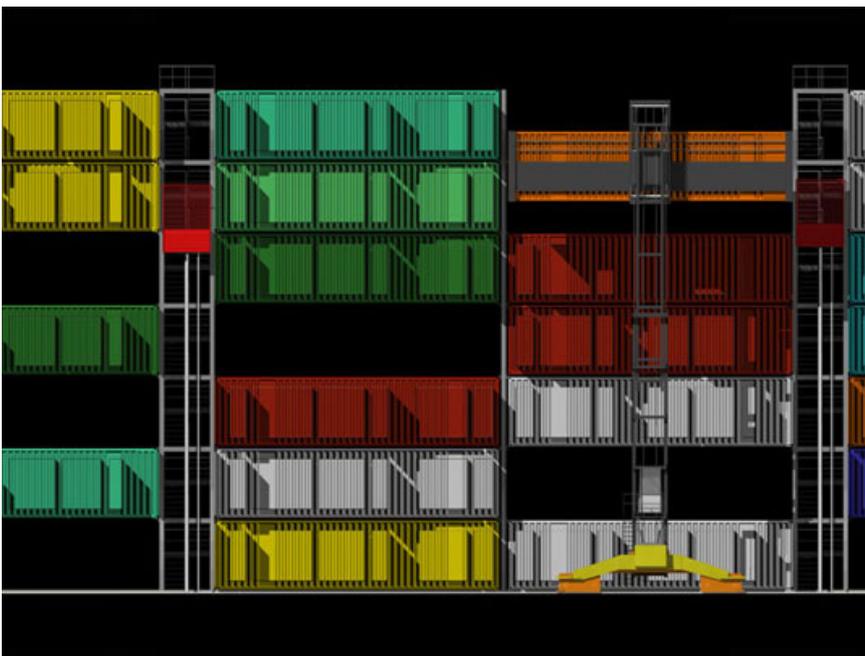


Fig 38. MDU's supporting frame and the special handler. Illustration. Source: <http://www.architakes.com/?p=1441>

69 Robert Kronenburg. *Portable Architecture: Design and Technology*. (Basel: Birkhauser, 2008), Pp. 114-17.

Geometry

“We use the cube as if it were the only acceptable model for our living spaces and, in doing so, we ignore countless other forms that might lead to more efficient, more beautiful, more economical, and certainly less worn-out environment. Why do we do it? Mr. Ford told us we must drive his black cars, but who told us that we must dwell in square or rectangular spaces, bound by four vertical walls intersecting at right angles?”⁷⁰ The most economic way to maximize the use of space is to stack each module on top of each other and juxtapose the mounds right against the next one on their long side, the same configuration as shipping containers would be stored. Therefore, the surfaces that can be used as fenestration and access are the bits that exposed at the front and the back for each unit. To make the remaining surfaces more functional the sectional rectangular space is truncated on four corners, each vertical interior wall becomes two surfaces that the bottom plane leans outward while the top plane leans inward. Simultaneously, upright bowtie shape in-between spaces also created externally that can be utilized for variety of services such as location for air handling units and cloths hanging, therefore the unpleasantness of the typical façade location of the said services is avoided.

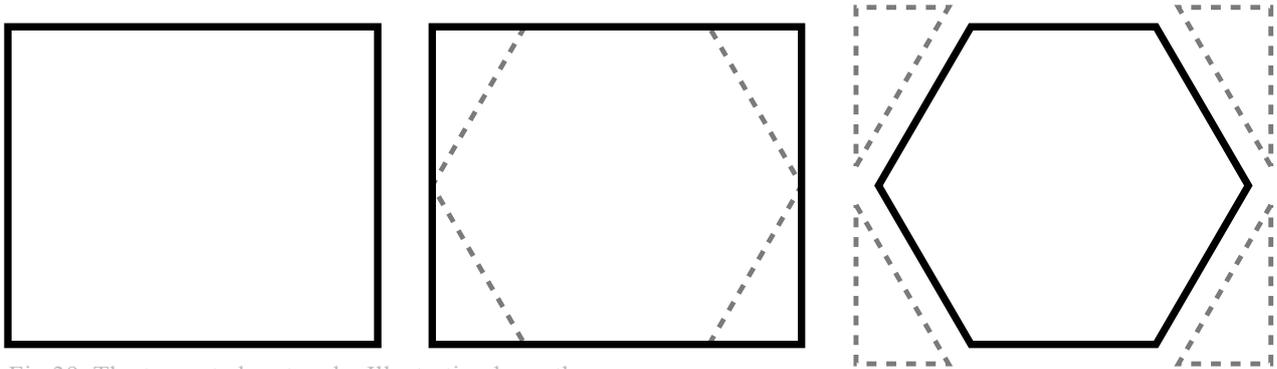


Fig 39. The truncated rectangle. Illustration by author.

The inclined walls may seem irrational in that usable internal space is reduced, but useable space does not necessarily mean useful space. The space in front of the bottom half of the wall are usually placed with furniture such as sofa and storage unit. How often do we reach to the very end of those low cupboards? Furthermore on the same issue, overhead spaces are even more difficult to use, as not many can reach to access items stored at the back of the top shelves without the assistance of a booster. Therefore, custom designed built-in furniture is not just a solution to the irregular space, but utilizes the less useable internal spaces into more useful external space. The storage spaces for the wall units may be reduced in half, but storage space should never be over-provided for temporary housing. Nevertheless, residents can make use of the street level mini storage when additional space is required. Truncation was used in a similar way in ‘James D. Wilson House’⁷¹ in Pensacola, Florida in 1950. The house consisted of a dozen of modular cubes abutting to each other, and each contained various functions on plan such as living, dining, sleeping, and carport. The corners of the cubes were truncated for providing numerous of services such as fenestration, column locations, fireplace, sliding doors, and circulation.

70 J. Francois Gabriel, ed. *Beyond the Cube: The Architecture of Space Frames & Polyhedra*. (New York: John Wiley & Sons, 1997), p. 7.

71 *Ibid.* Pp. 105-11.

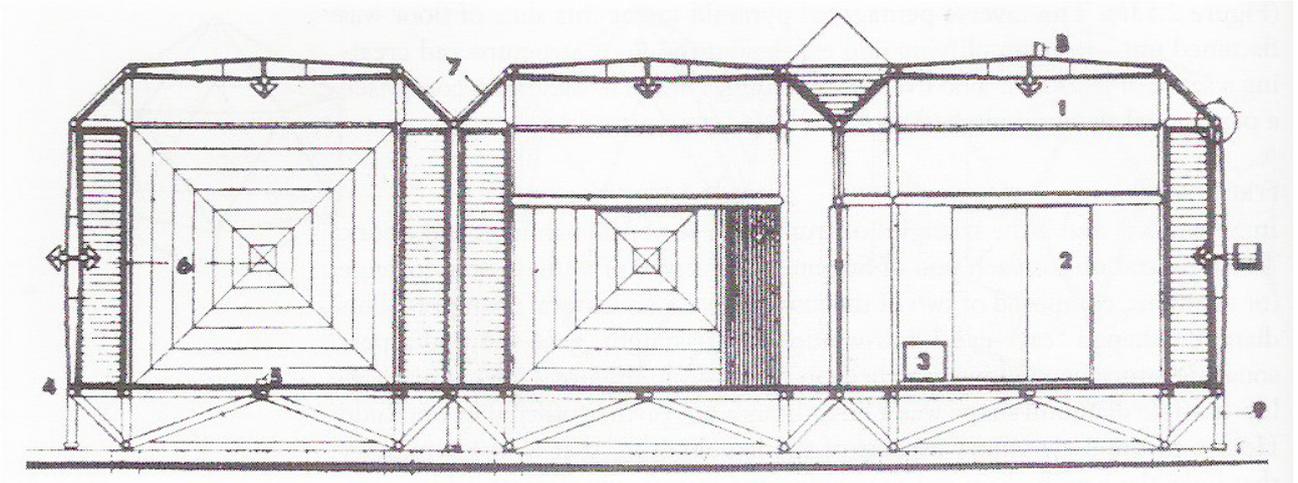


Fig 40. James D. Wilson House, Pensacola, Florida, 1950. Section. Source: J. Francois Gabriel, ed. *Beyond the Cube: The Architecture of Space Frames & Polyhedra*. (New York: John Wiley & Sons, 1997), p. 106.

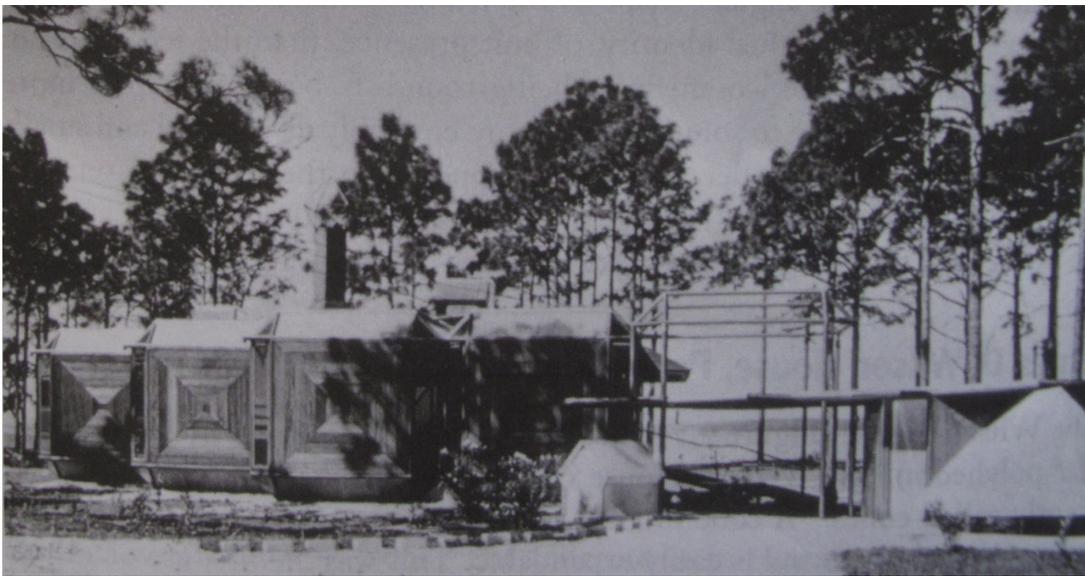


Fig 41. James D. Wilson House, Pensacola, Florida, 1950. Photograph. Source: Ibid.

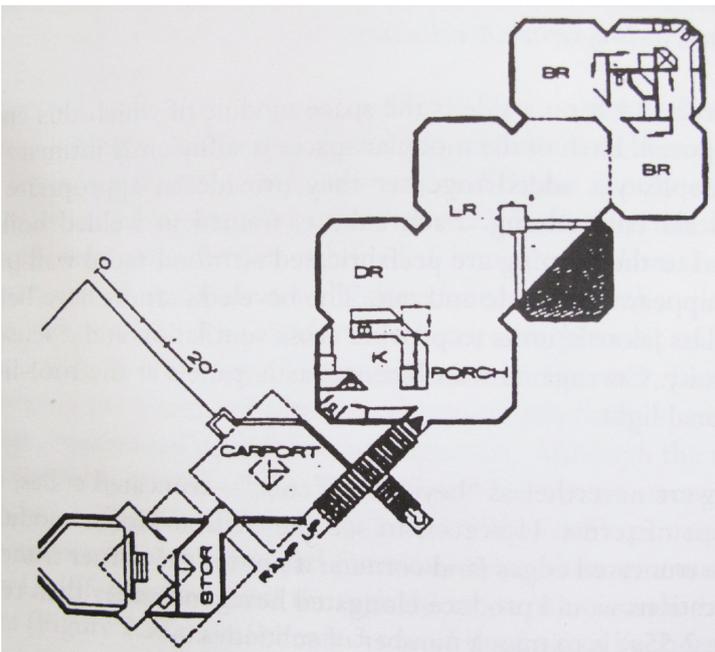


Fig 42. James D. Wilson House, Pensacola, Florida, 1950. Plan. Source: Ibid.

Penalized construction

The smallest flat that the housing development will provide is the studio apartment, which consists of two 2-meter length modules, then the one-bed apartment of three modules and the largest with four modules as the two-bed apartment. Each module consists of six panels and jointed as one with pin hinge system. With all six panels linking together to form a hexagonal cell, there are series of internal threaded tubes semi-embedded into two joint edges of each panel, to be connected and fastened with six 2-meter threaded rods at every corner of the hexagon. The threaded rod is also designed to fasten beyond its panel and jointed to the adjacent module. The hinge system is not designed for any pivoting movement, the rationale being based on the minimization of separated parts and simplification of jointing technique. This results in faster and more precise construction.

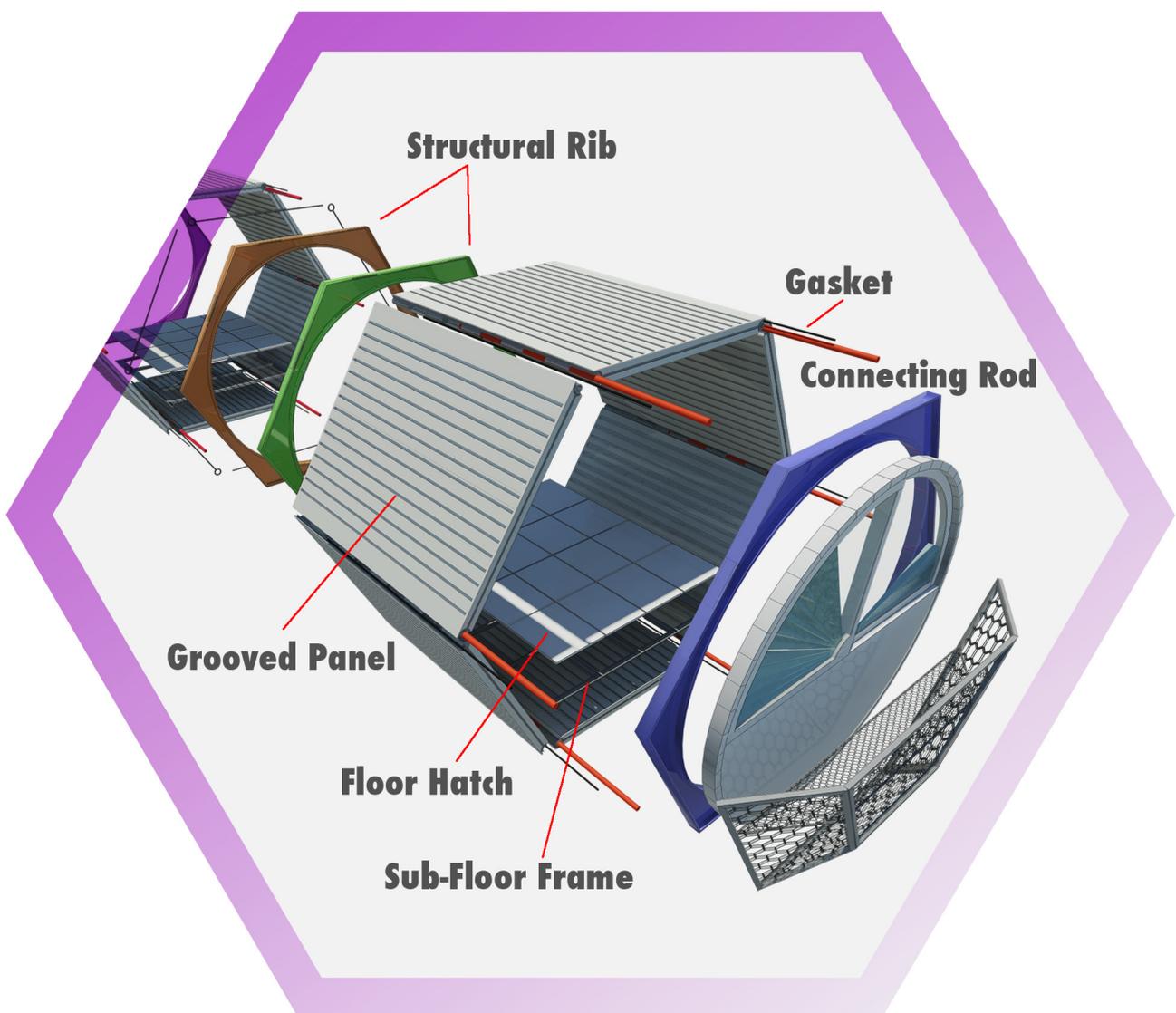


Fig 43. The H.I.V.E penalized system. Image by author.

The panel can be classified into two types, interchangeable to each other. The flat panel that is predominantly used as the floor and lower wall, and the utilization panel with a cutout hole in the middle that can be inserted with various plug-in functions, including fan-blind window, light dome, LED lighting, extract fan and air diffuser.

Both panels are made out of same materials in a composite structure. The outer layer is plastic lumber, and sandwiched with 'Foamglas'⁷² insulation slaps. One of the primary design intentions is to make the panel as thin as possible, hence the plastic lumber layer is 30mm on each side and only allows 40mm in the middle for thermal insulation. Foamglas is the most suitable product for this work as it is manufactured in the thickness as thin as 38mm. Although compatible thickness can be found on other products in the market, such as mineral fiber and polystyrene slaps, Foamglas surpasses

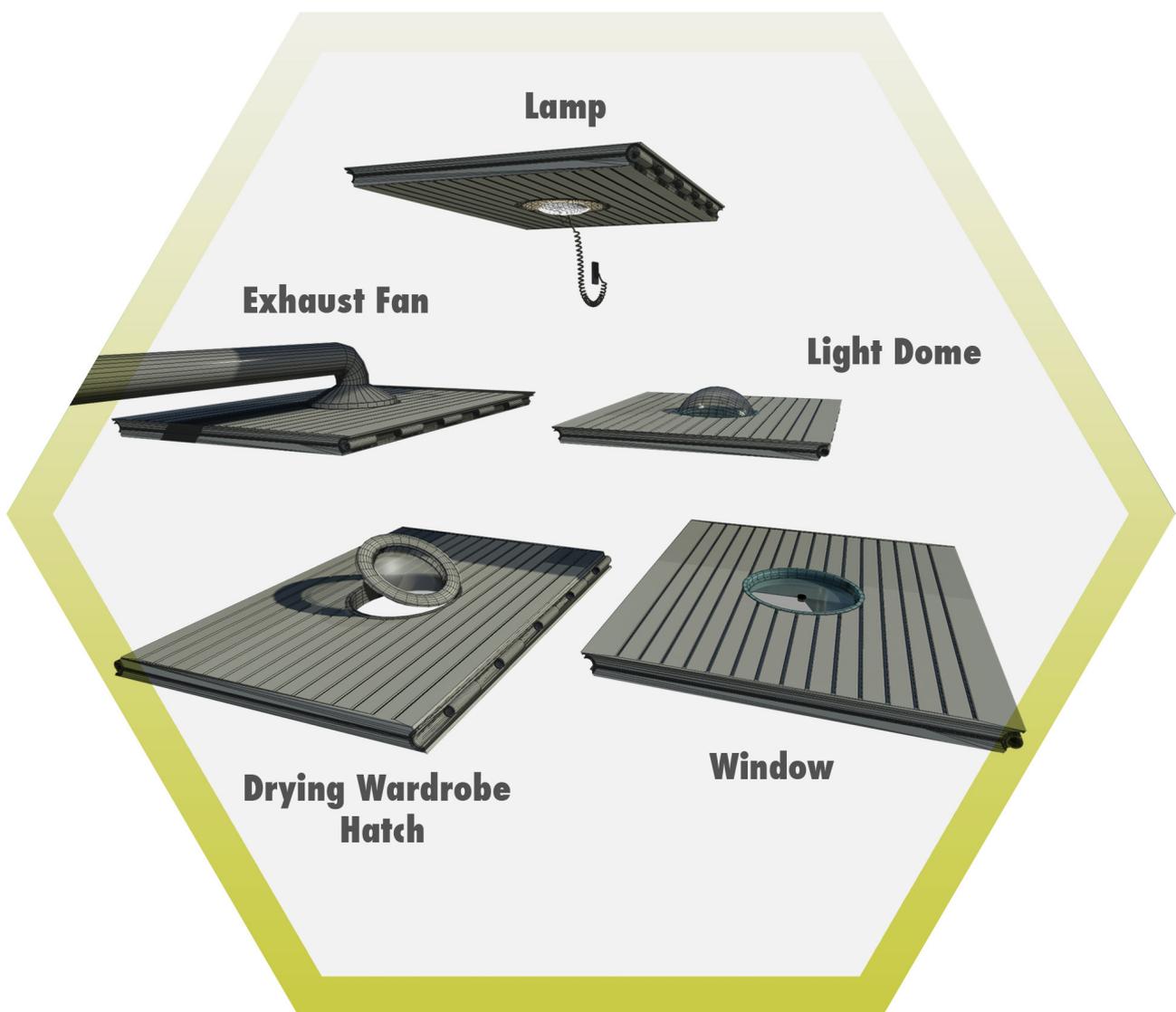


Fig 44. Utilization Panel. Image by author.

72 Foamglas® Insulation Systems. Product Booklet. Rev. 2/09. Pp. 1-34. http://www.programs.insulation.org/Scripts/4Disapi.dll/4DACTION/WebFile/FOAMGLAS_Cellular_Glass_Insulation.pdf?action=Category&Category=MTL&WFID_W=30&Time=1038713293&MenuKey=234

other possible products in many way beside it has a slight higher thermal conductivity than typical mineral fiber and polystyrene. Firstly, it is the most rigid insulation that the bonding with the panel skin will actually add structural stiffness to the system and it will not deform, where the other two materials will eventually deform in time and climate factors, and only have a fraction of Foamglas' strength. Secondly, the insulation has to be completed and concealed within the plastic lumber outer skin for the purpose of air, weather, odour and vermin tightness, which Foamglas is made out of 100% glass that it will not melt or burn in the process of molding, in fact, it has been used widely as external insulation for protecting piping and equipment from fire damage.

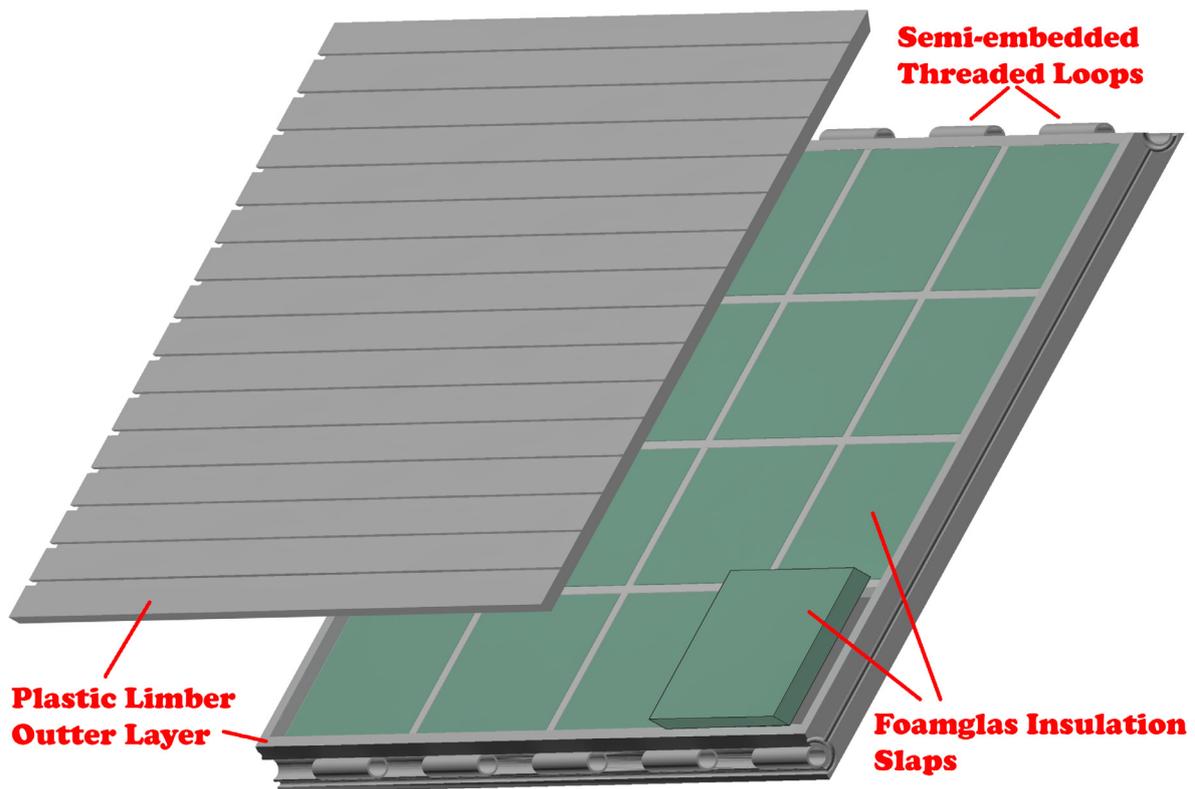


Fig 45. Composition of the H.I.V.E panel. Illustration by author.

Plastic lumber⁷³ (PL) is a 100% recyclable material made out of waste plastic bottles, fiberglass and selective additives, it is waterproof, and resistant to rot and mold. It is commonly used for outdoor decking. PL is easily confused with another composite material Wood-plastic composites (WPCs) that are also used for outdoor decking. Unlike PL, WPCs is a combination of recycle plastics and wood fibers that absorb water, not 100% rot resistant, and more difficult to recycle. In addition, PL has been used for various of architectural application from molding and trims, window and door frames, outdoor and indoor furniture, siding and cladding, PL can even be applied on structural use. However, the main reason of choosing the material is based on the low-maintenance factor, which PL is highly stain resistant and do not require painting, colour is pre added during the process of manufacturing.

73 American Plastic Lumber, Inc. "Structural Lumber: Technical Data," accessed September 13, 2012. http://www.american-plasticlumber.com/tech_specs/structural_lumber_technical_data.htm.

In addition to the maintenance issue, the panelized system allows replacement of any of the six panels when one is damaged, where a pre-cast entity cell cannot match. However, it leads to one problem to be resolved as the unsteadiness caused by the pin hinged joints. Hence structural ribs at two ends of each module are put in for stabilizing the structure.

The structural rib is also made out of plastic lumber and has the web and flange design that comes from the I-Beam. The prefabricated panel also feature an 'Utility grove mounting system' that is visually similar to the retail wall display system, but it is originally inspired by the 'Weaver rail mount system'⁷⁴ that was developed for military purpose, it is a slotted steel rail on the assault rifles that allows a universal mounting for its accessories such as telescopic sights, light torches, shotguns, grenade launchers and iPhones. The 'Utility grove mounting system' includes a series of horizontal groves on both sides of the panel that are formed through the molding process, also in conjunction with specially designed mounting 'T bolt' that allow every internal and external fixtures to be secured on the apartments' surfaces. Examples include cabinetries, sanitary appliances, built-in furniture, structural ribs, false floor structural frame, ventilation gills, sunlight reflectors, assemblage sliding plates, supporting structure for circulation and others.

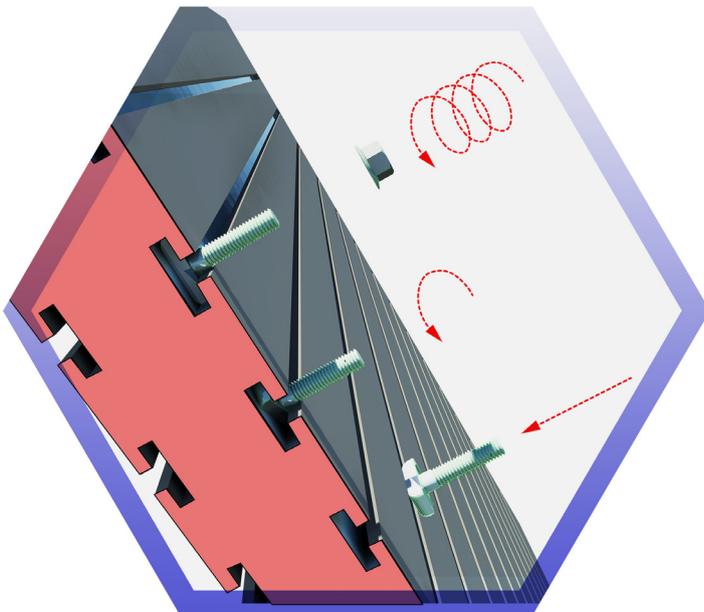


Fig 46. Utility grove mount system with T-Bolt. Image by author.



Fig 47. Weaver Rail Mount. Photograph.
Source: <http://bestairrifle.org/airsoft-rifles/aim-sports-solid-metal-carbine-length-weaver-picatinny-quad-rail-handguard-system>

⁷⁴ Wikipedia, s.v. "Weaver Rail Mount." Accessed August 3, 2012. http://en.wikipedia.org/wiki/Weaver_rail_mount.

Stacking system

Each housing module is preassembled in the factory with built-in furniture and equipment, then transported to the site for final assembly using the 'telescopic handler'⁷⁵, some time known as 'telehandler'. Its function is very much like a forklift but enhanced with a telescopic boom that can be extended forward and upward as desired. In general, 'telehandler' also has a higher reach and carry heavier load, some high performance machine can lift over 10 tones and reach over 15 meters. The 'telehandler' can also be fitted with a range of attachments on the end of the boom for various tasks, such as bucket, muck grab and lift table that can perform varieties of site and construction work for the under-bridge housing. Unquestionably however the pallet forks attachment will transfer housing modules into place.



Fig48. Telescopic handler (telehandler).
Photograph.
Source: <http://www.directindustry.com/prod/genie/telehandlers-9218-52547.html>.

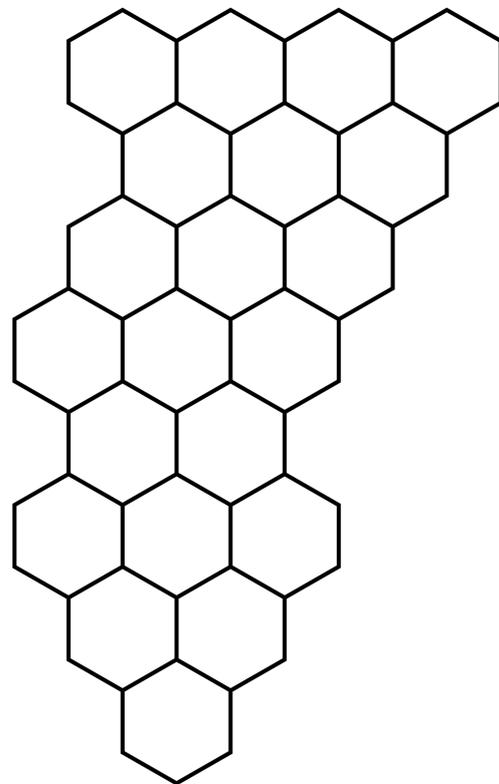


Fig 49. The hexagonal pattern of 'Honeycomb.' Illustration by author.

The most time consuming process in this proposal was the configuration exercises around the stacking pattern for the hexagonal prism modules. The final chosen configuration is inspired by the most common hexagonal pattern order, which is the perfectly juxtaposing layout that we see on honeycomb. In Fig 50, by squeezing H1 and H2 toward each other that forces H3 and H4 to move in opposite directions,

75 J.J Thompson. "How High Will a Telescopic Forklift Go?" Ezine Articles. Submitted on June 25, 2009. <http://ezinearticles.com/?How-High-Will-a-Telescopic-Forklift-Go?&id=2526569>.

up and down, a space is also opened up in the middle of four which becomes the services space. While bringing H1 and H2 closer together the services space become taller and slenderer, vice versa by putting away H1 and H2 the space become shorter and broader. However, the shape and size of the services space is only concerned with accessibility for maintenance purposes. The major benefits of the interchangeable system is the ability to alter the overall height of the three stories configuration, which allow the H.I.V.E system to slot under the majority of under-bridge spaces with various heights.

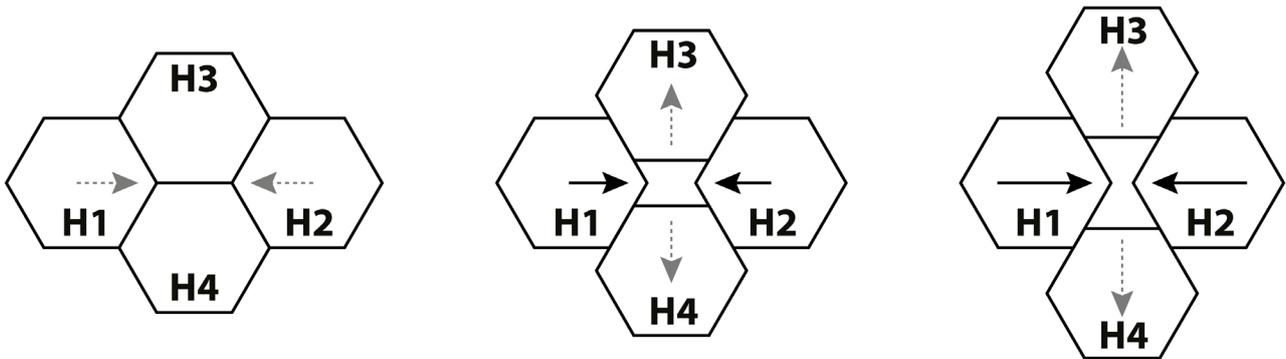


Fig 50. Configurations of the stacking system. Illustration by author.

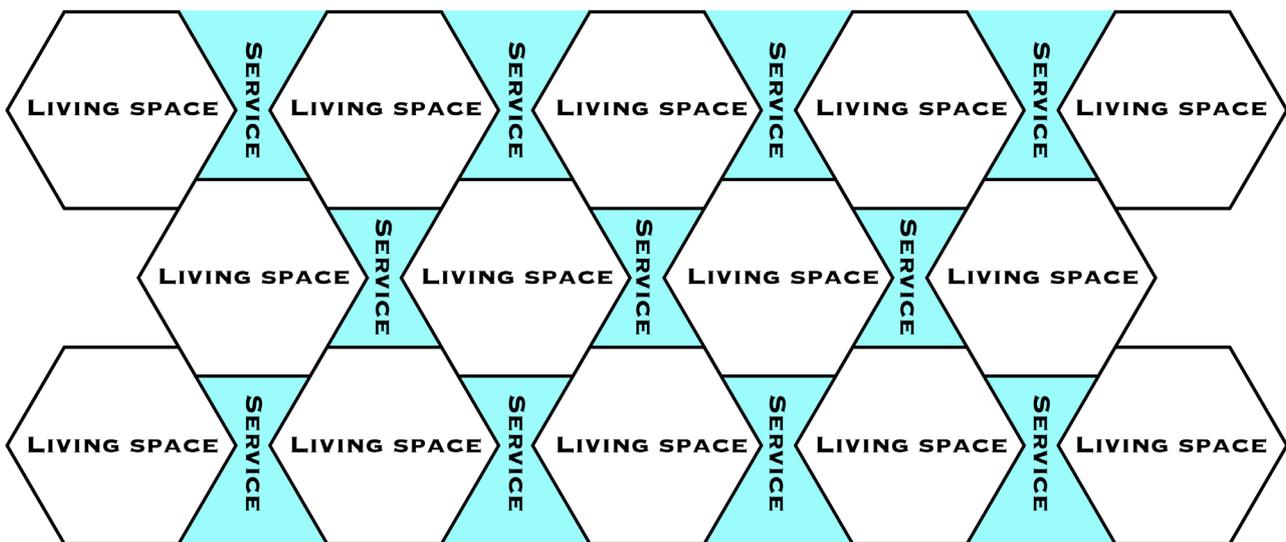


Fig 51. The final configuration of the under-bridge interim housing. Illustration by author.

In terms of the stacking structure, unlike the MDU by LOT-EK there will not be a supporting structural frame. Housing modules are simply stacked on top of one another. The modules on the bottom row of the complex are equally spaced out, and bottom-mounted with aluminum-alloy foot-stands that can be individually height-adjusted to the uneven surfaces of the under-bridge space, which avoids the provision of time and cost consuming site work for a concrete flat-bed. The second row (first floor) is dedicated to the heavier and larger housing units, the 1-bed and 2-bed. Each module will be lifted and pushed in place in a sliding motion by the 'telehandler', and in repeated actions to joint all necessary modules together for forming complete flats. The third row operates the same way as for the second row, but it is mainly designed for the smallest studio flat. Nevertheless, they can be added with extra modules

to become bigger flats when required. Therefore, the expanding capability is only needed on the top level, which makes a supporting structural frame unnecessary, and also saved in construction cost and time. To ensure the smoothness in the operation of the sliding assemblage and stability in the stacking system that steel sliding plates will be mounted on the modules where the contact occurs, which works similarly to drawer rails.

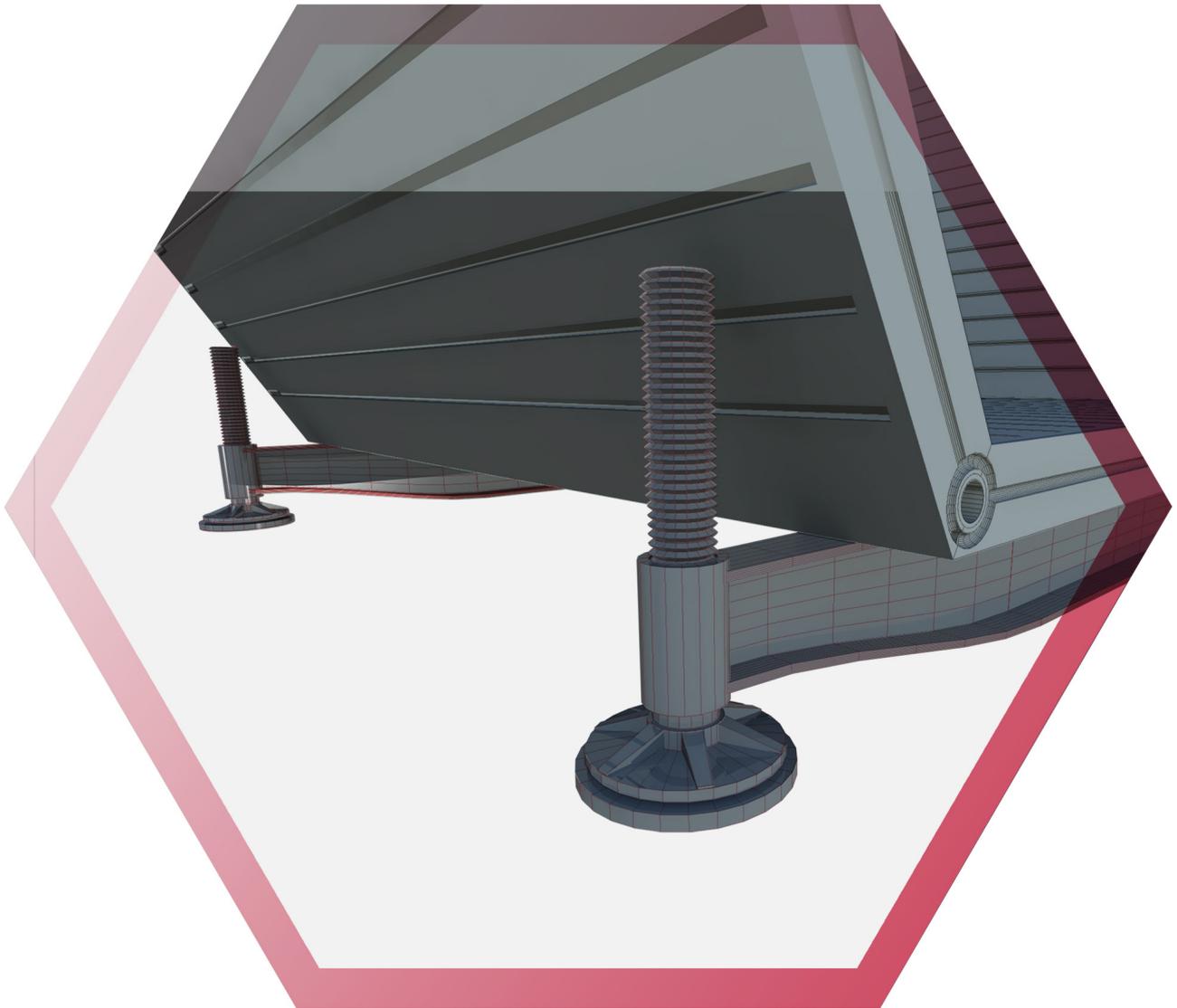


Fig 52. Aluminum-alloy foot-stands. Image by author.

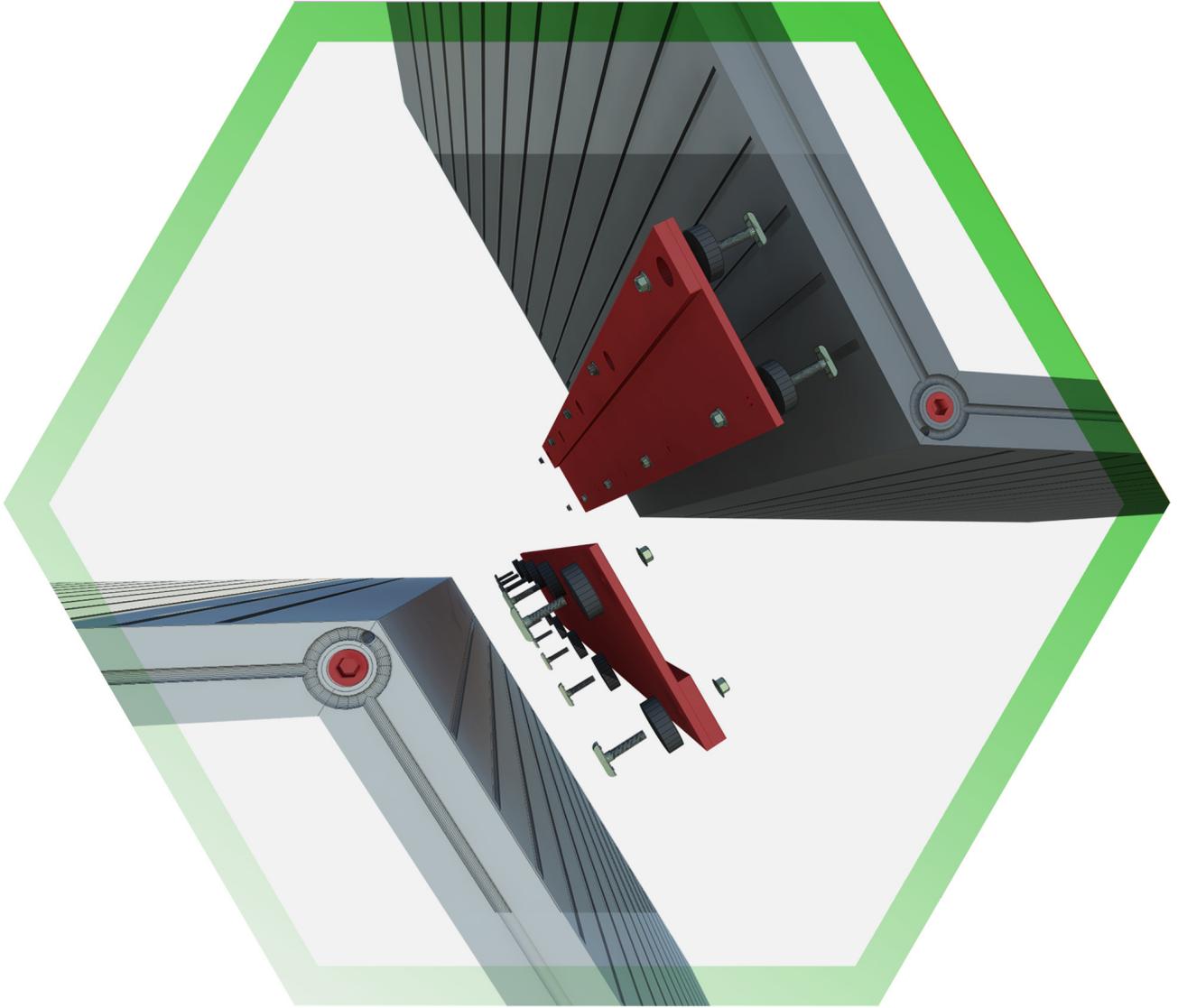


Fig 53. The sliding plates. Image by author.

Airtightness

There are many environmental concerns in the inhabitation under bridge. These include such issue as air pollution, noise, odour and dust nuisances. It is for these reasons that government has forbidden the utilization of under-bridge spaces for residential use. Under-bridge spaces are not the only places affected by these environmental problems, there are apartments that only stand few meters away from the motorway bridges, about the width of a driving lane. The lower level apartment users would have suffered the same as the under-bridges would. In fact it could be argued the apartment residents possibly would experience a higher level of direct noise that generates from the motorway while the under-bridge spaces only receive less intensive reflected noise. Nevertheless, for persuading the government to accept the idea of under-bridge inhabitation, it needs a promising solution on environmental control. The method is just simply to make the housing flats airtight in a way that minimizes all the unwanted external ingress, besides providing high quality double glazed windows and air-sealed entrance doors. The challenge is how to seal the joints between panels and between modules in such a way that dismantlement and reassembly can be easily achieved. Therefore, every jointing edge is molded with concave grooves for embracing the round rubber gaskets. However, an open window is included in every apartment, along with the perforated gated entrance that the cross ventilation can be used when the mechanical ventilation is not desired or under-maintenance.

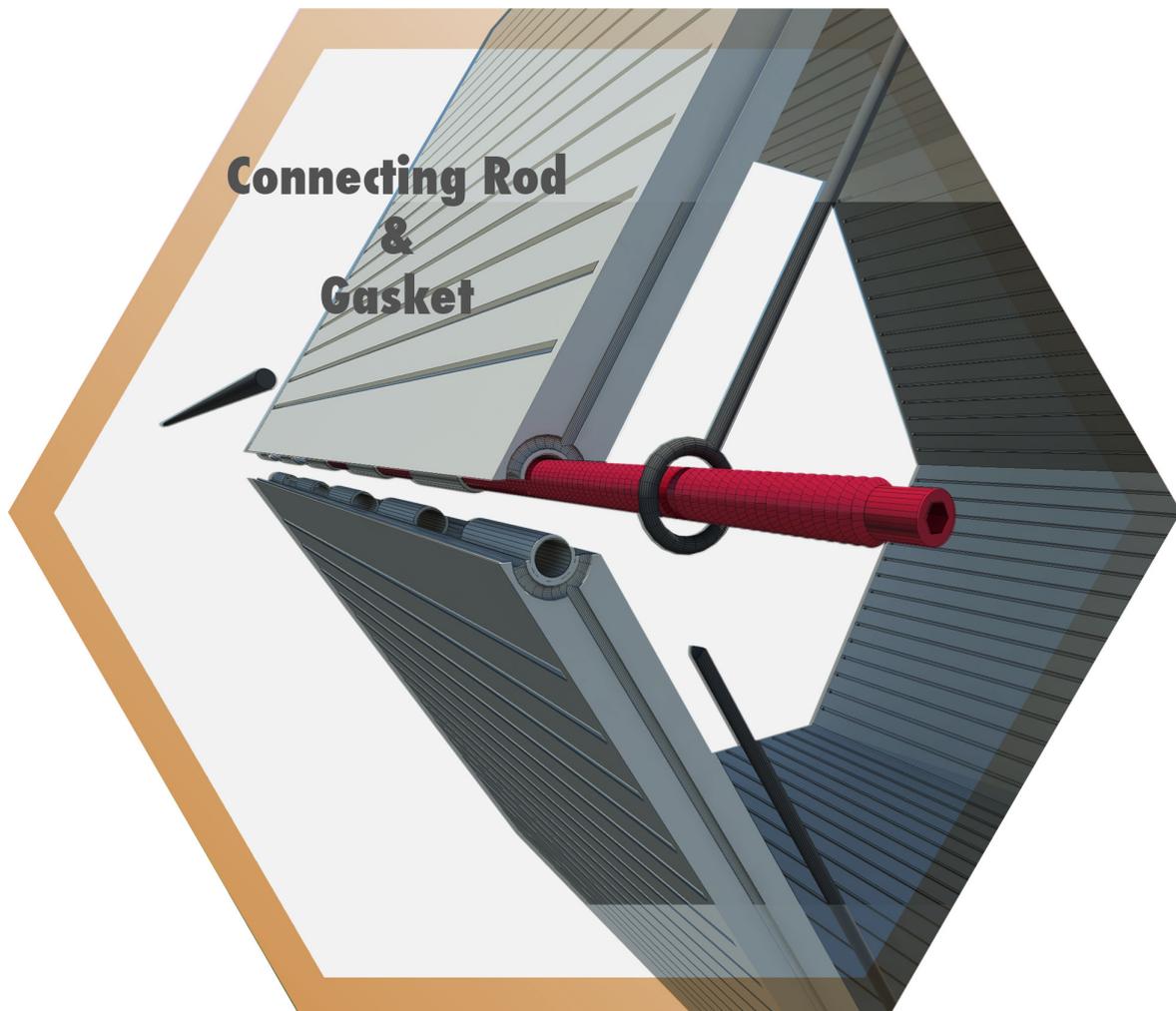


Fig 54. Gasket. Image by author.

Services

Hong Kong is a subtropical city. The climate is predominantly hot and humid, and the air-conditioning unit is considerably an essential part of living. However, air-conditioning is rather expensive to run, which may not be affordable by those low-income residents of Sham Shui Po. Therefore, a more economic and eco-friendly system is equipped for every flat and that is the 'groundwater bore heat exchange ventilation system'. Based on the topography advantages of Hong Kong that mostly consist of hilly terrain at the inland areas, plentiful of rainwater can be collected and stores underground in soil pore, fractured rock and gaps between gravels. Groundwater has a relatively lower temperature than the hot humid air temperature. Therefore the urban areas of Hong Kong can easily make use of the groundwater in a heat exchange system. The system include an onsite underground bore for pumping up the cool groundwater, intake fans on the circulation side of the bowtie shaped service spaces, heat exchangers in control rooms, air handling units within the services spaces, and exhaust fans on the façade. The service spaces also include cloth-drying wardrobes that are integrated to the ventilation system. Because of its low running cost, the system is designed to run continuously. It brings in constant fresh air and takes away the heat and humidity. In the event of mechanical maintenance or occupants' desire, the option of natural cross ventilation can also be achieved by using the doors and windows.

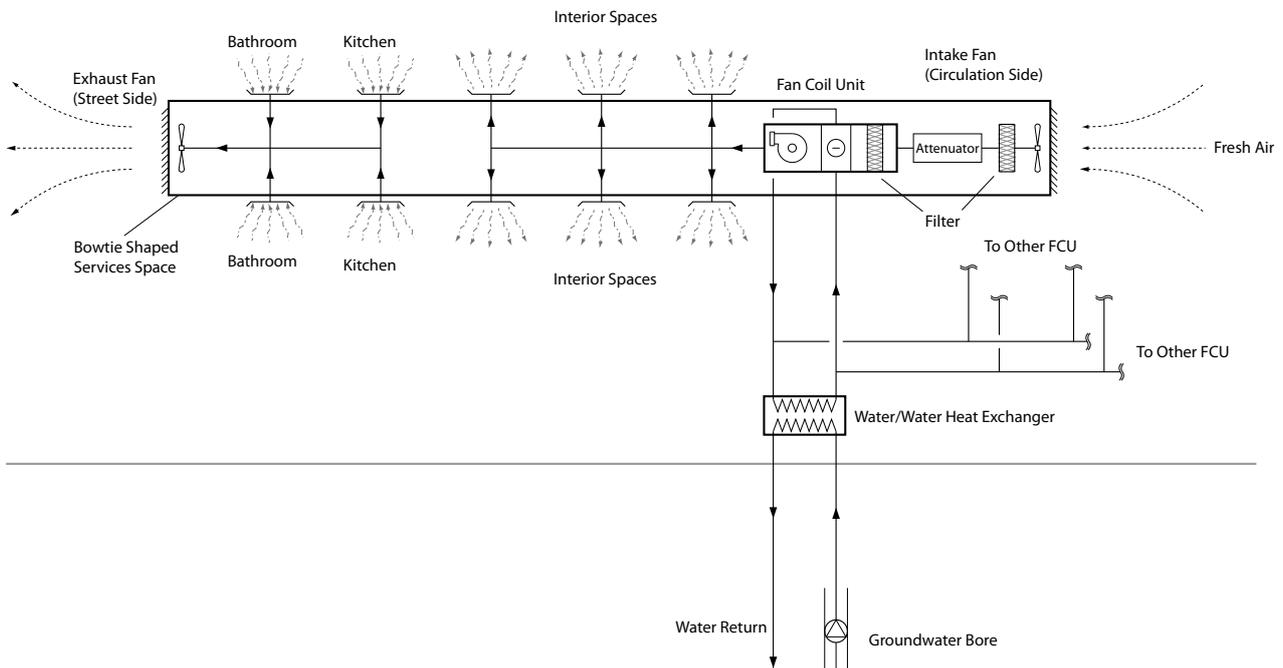
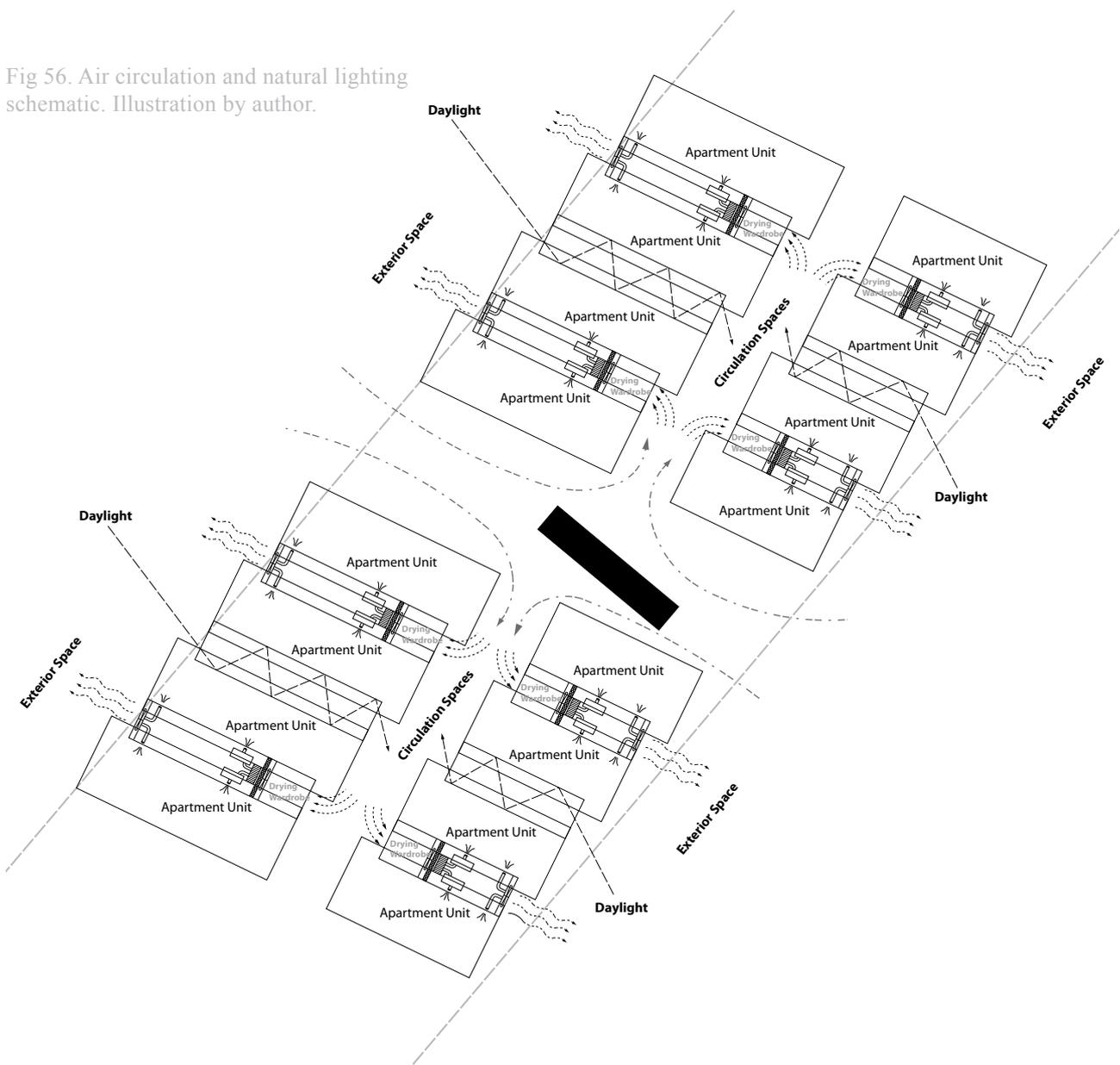


Fig 55. Groundwater bore heat exchange ventilation system schematic. Illustration by author.

Passive lighting is another function for these spaces. The internal surfaces are covered with mirror-faced plastic sheets and fixed-windows with frosted glass, with sunlight collectors that reach out at the street side end and bring in the natural light. This bounces around in the mirror-faced spaces, illuminating the interior with natural light. Natural light also defuses through the frosted glass and enters the apartments on both sides. Other passive lighting devices include the triangular sunlight reflectors that hang above the apartments on the second floor, together with the underside surfaces of the bridge painted in white. Here the natural light bounces off the reflectors to the underside of the bridge, then to the circulation spaces on the second floor. Cutout holes on the second floor walking platform act as the skylights and assist in illuminating the first floor circulation spaces.

Fig 56. Air circulation and natural lighting schematic. Illustration by author.



The form of the hexagonal prism only allows a small horizontal plane as the interior floor, therefore a false floor is elevated in order to increase the floor area, as well as creating a under-floor storage space with flip-up hatches, and integrated furniture such as the half-sunken desk, also services on two sides of the under-floor space to coordinate with all the utilities that can be arranged alongside the two interior walls,

such as kitchen cabinetry including electricity cooking hob, refrigeration and sink, compact size washing machine, floor mounted power points and telecommunication jack point, and other essentials such as flush toilet, wash hand basin and shower unit. Water, electricity, phone line and drainage are fed from the allocated control rooms and follows the circulation path on the underside, then plug-in to the inlet or outlet points on the bottom of the entrances of each apartment. There will be no gas supply as it is a sensitive issue that will not comply with the under-bridge fire safety regulations. Since all services are coming up from the under-floor space, which leaves the wall panels free of internal wiring and piping that retains its maximum efficiency in thermal insulation and airtightness.

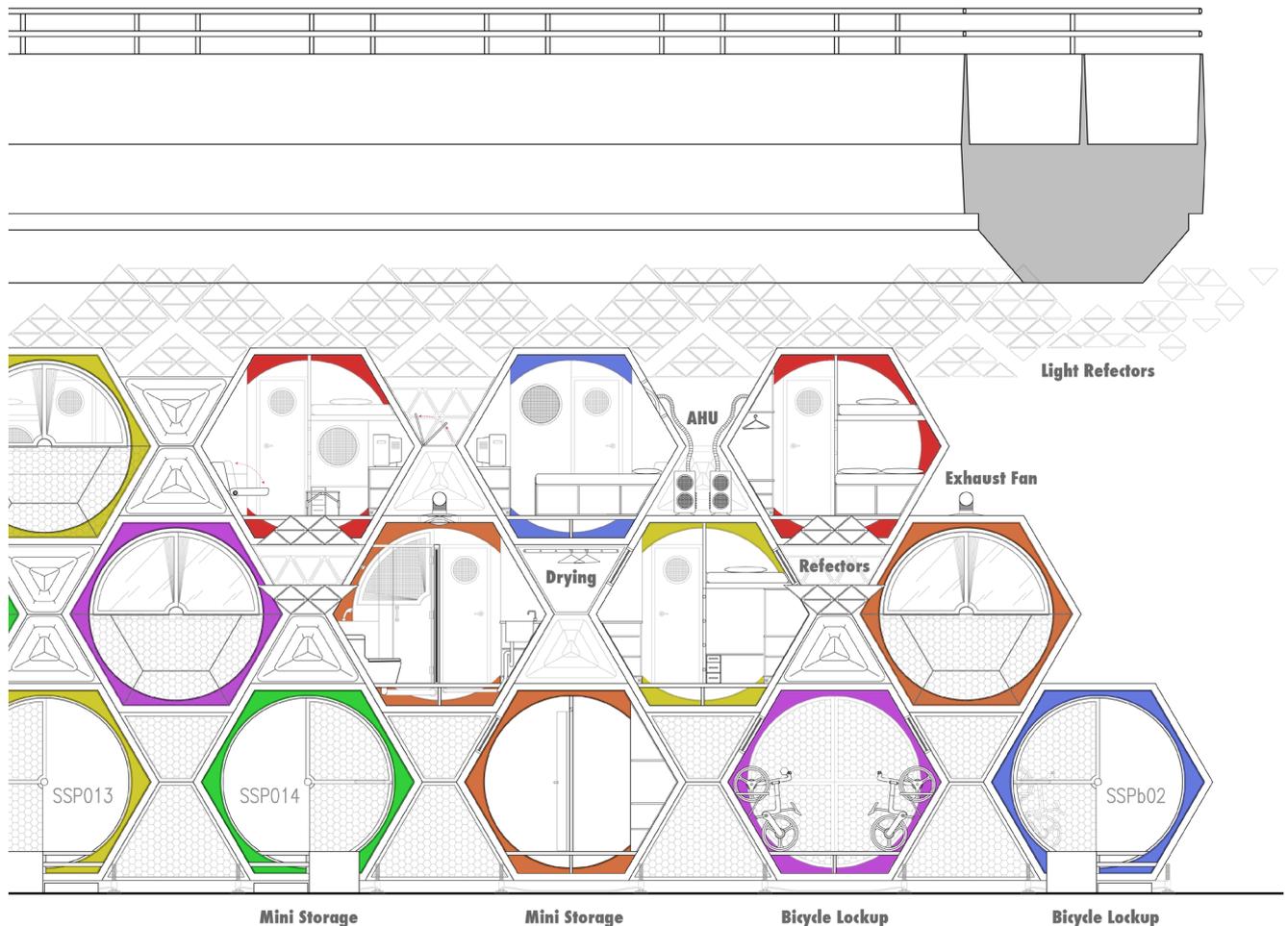


Fig 57. Cross-section/Elevation. Illustration by author. Not in scale.

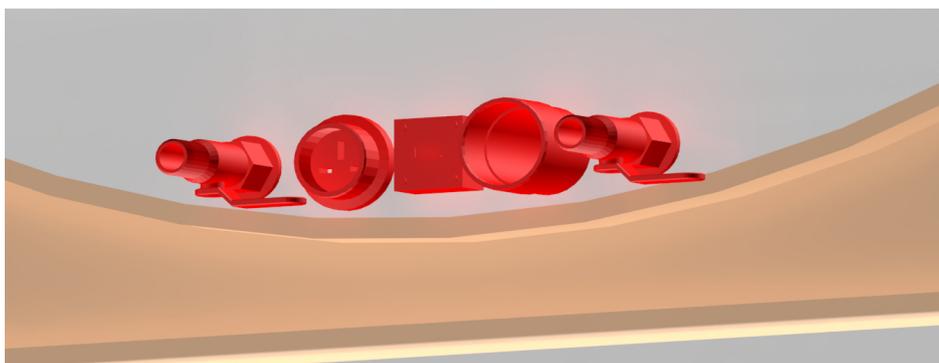


Fig 58. The services umbilical cord system on the exterior of each apartment. Image by author.

Interior

The pre-assembled modules are predetermined with different functions. The first module contains the functions of kitchen, bathroom and entrance, and then there is the sleeping and closet module that can be reconfigured to suit individuals' need. The last module is the living module or a living/sleeping combined module for the studio apartment with the only outlook window, which can also be rearranged in many ways. Because of the relatively small area of the housing apartments, the interior space can be very constrained. Adding a few square meters to the livable space can be done physically by renting an extra module, but can be done mentally by tricking the mind. "Perceived density emphasizes the interaction between the individual and the environment; therefore, it is not the actual physical density, but the perception of density through this man made environment interaction that matters. Prior studies concerning the indoor environment have shown that alteration of density and crowding perception is feasible through architectural features such as colour, brightness, room shape, window size, ceiling height, amount of daylight, use of screen and partition, and arrangement of furniture."⁷⁶ In order to make the space feel more spacious, all furniture is arranged against the walls to free the central space, large glazed outlook window are used, maximizing the use of natural light, and most importantly the use of light colour scheme.



Fig 59. Apartment floor plans. Illustration by author. Not in scale.

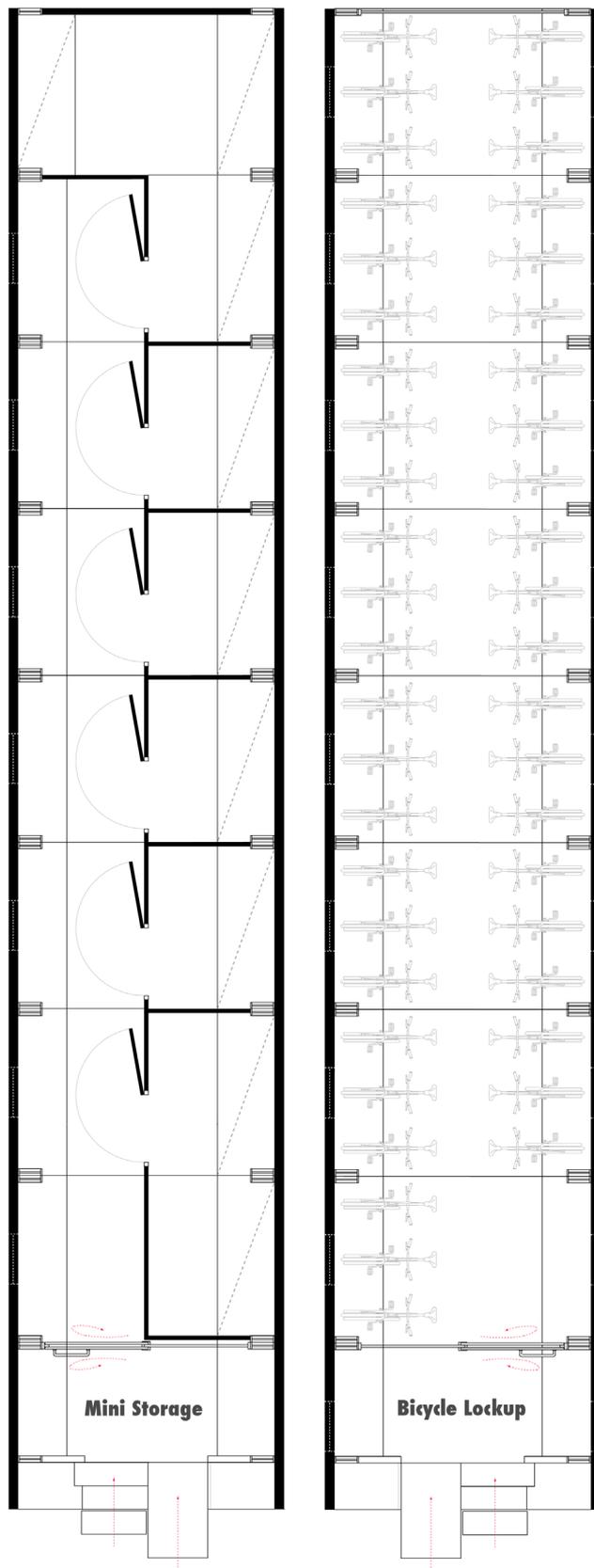


Fig 60. Street level floor plans. Illustration by author. Not in scale.

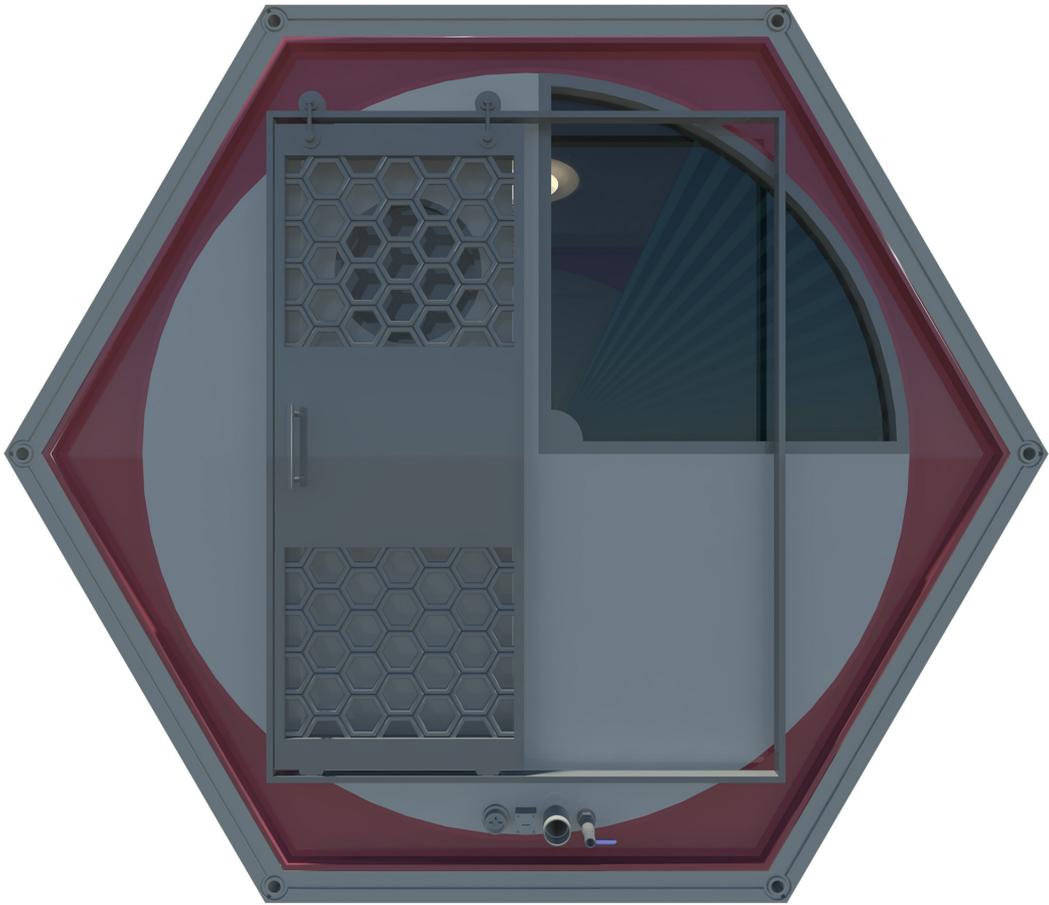


Fig 61. Apartment Entrance. Image by author.



Fig 62. Kitchen & Bath. Image by author.

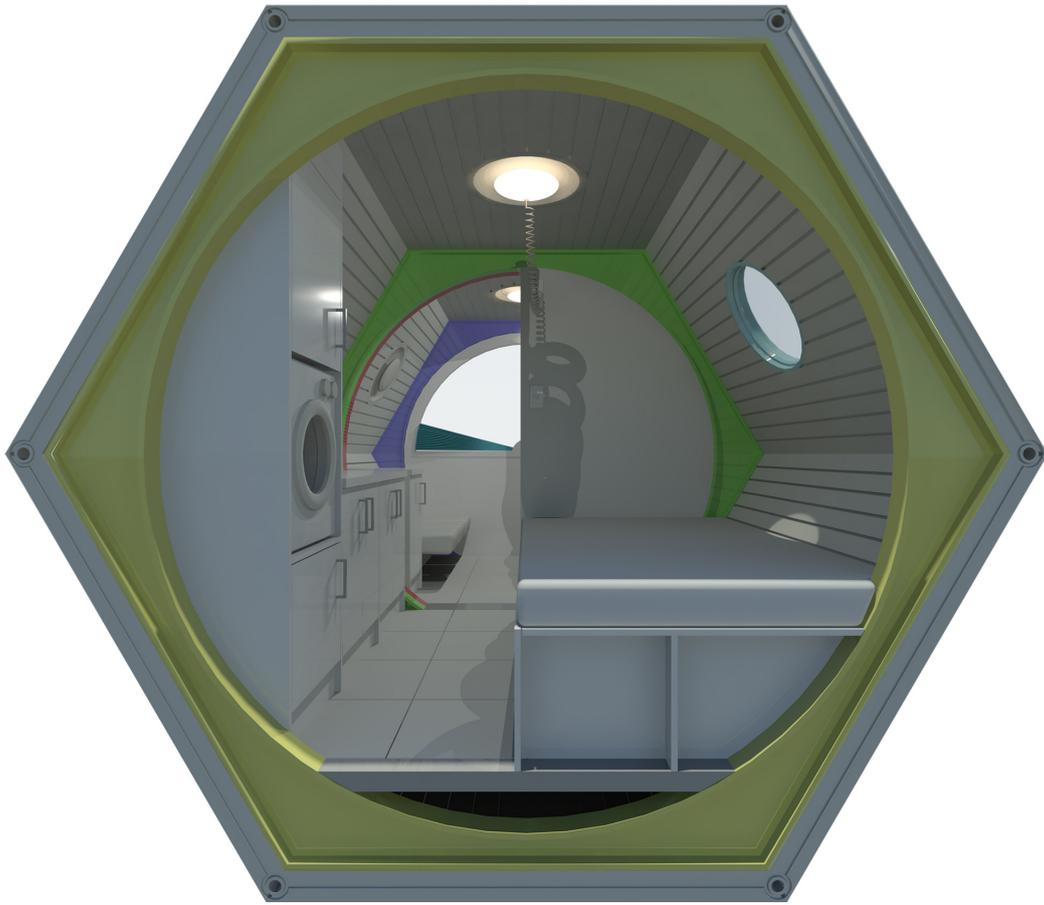


Fig 63. Laundry & bed. Image by author.

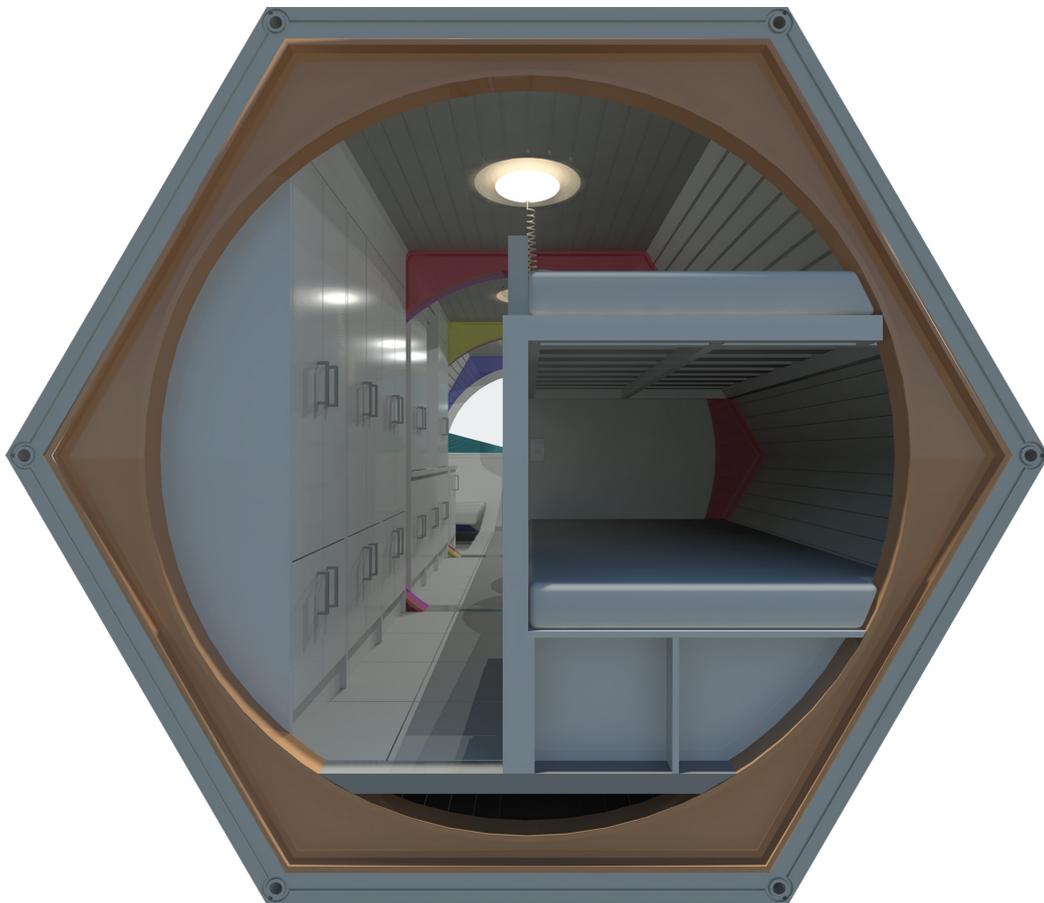


Fig 64. Double bunk bed. Image by author.



Fig 65. Studio living. Image by author.

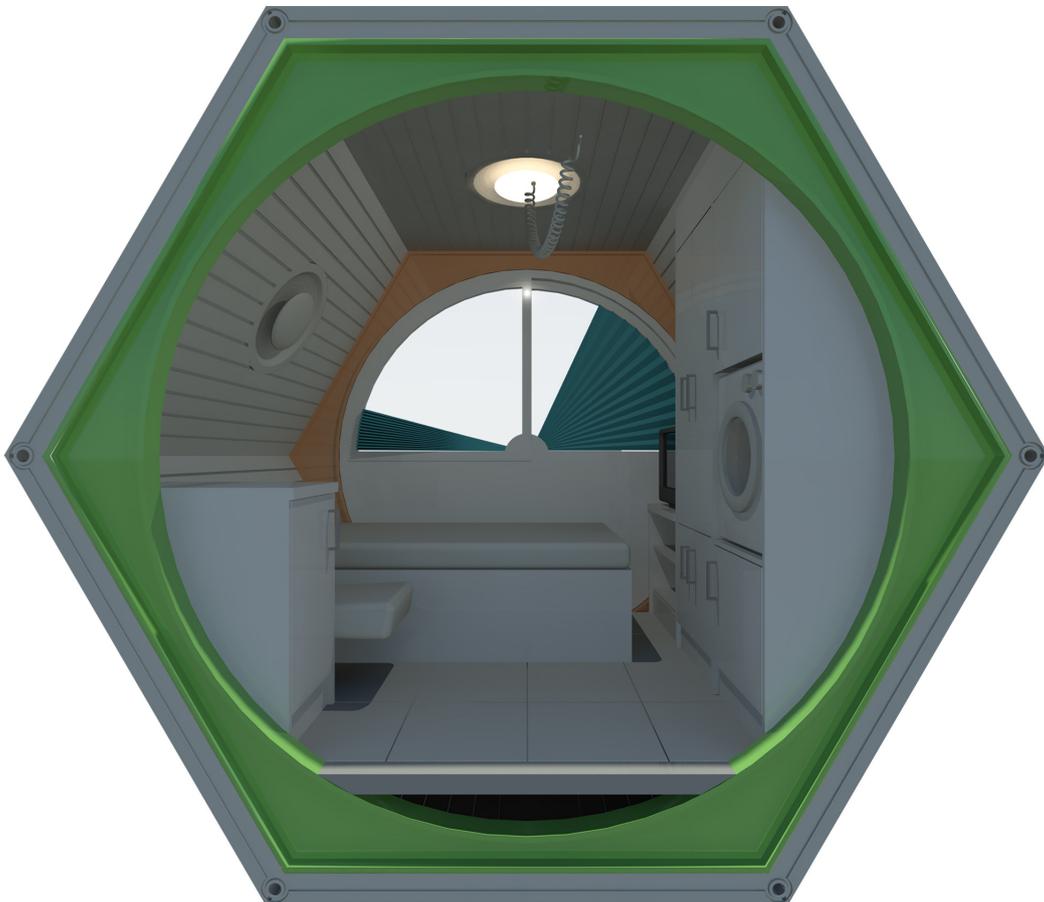


Fig 66. Elderly living. Image by author.

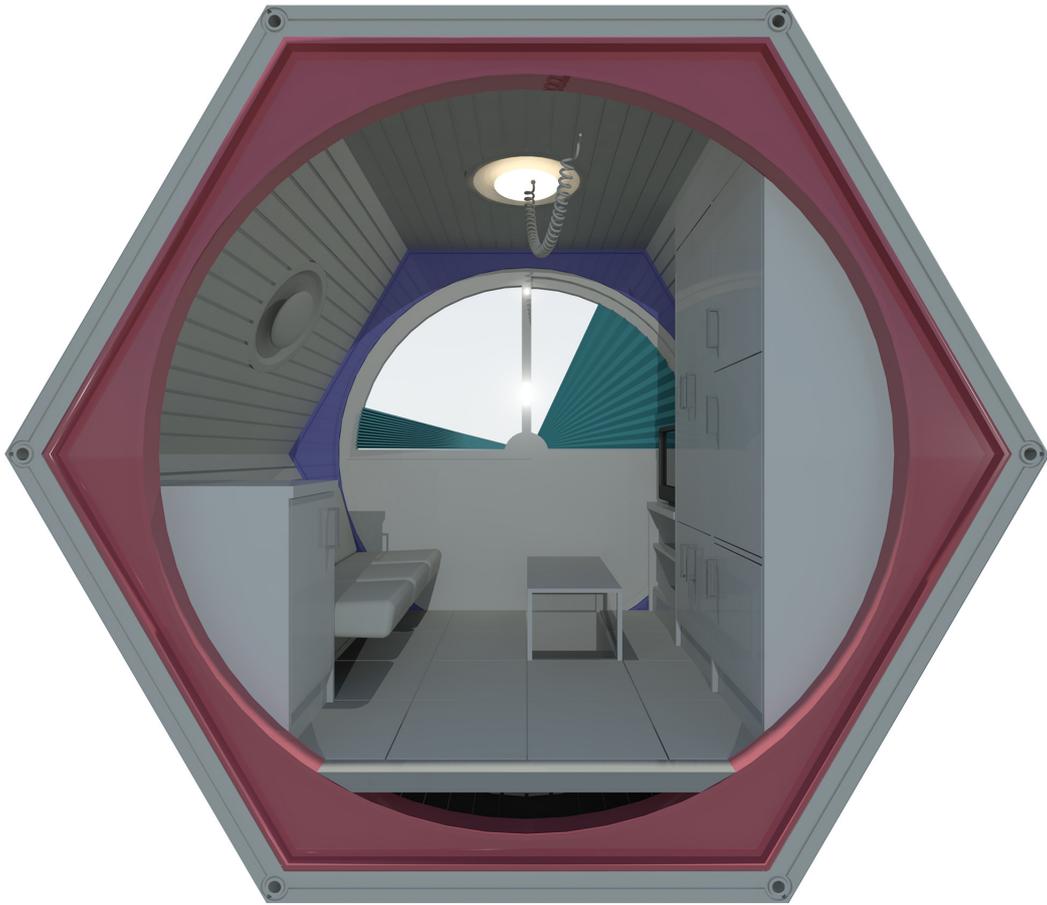


Fig 67. Family Living. Image by author.

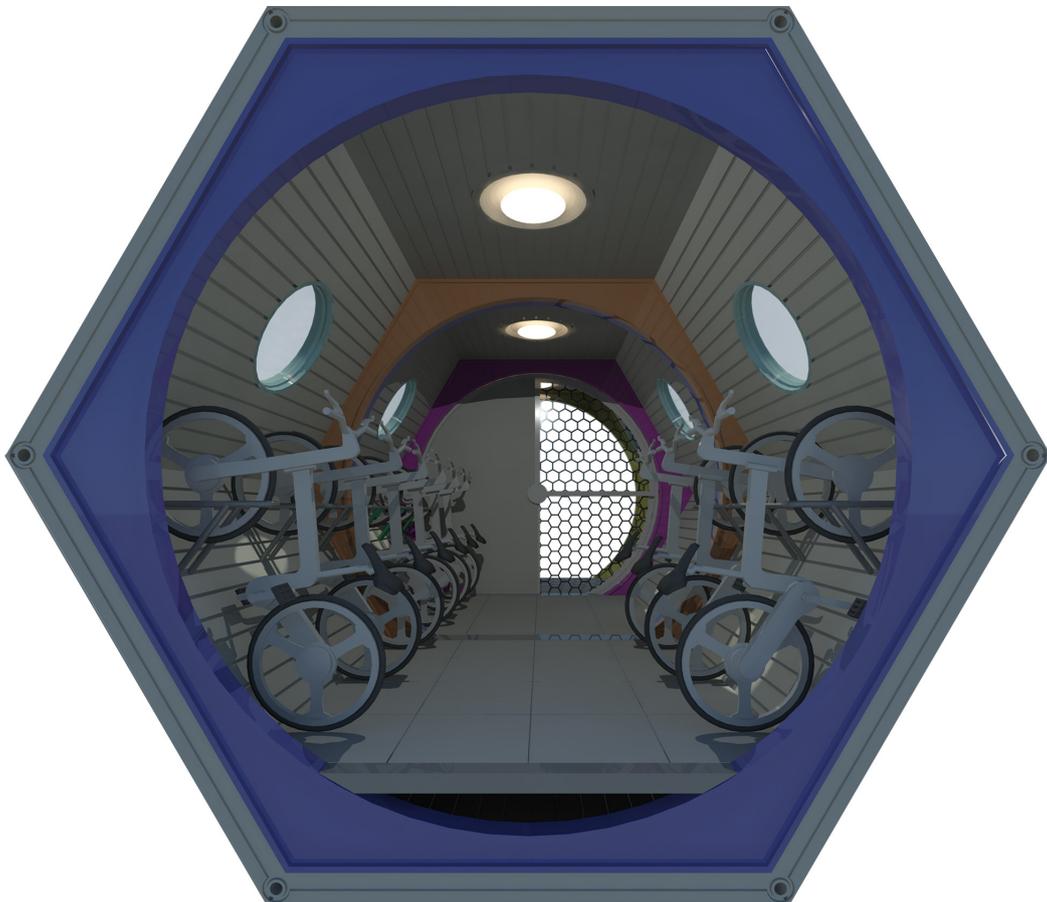


Fig 68. Bicycle lockup. Image by author.

Site-specific components

Beside the removal of vegetation on vacant under-bridge spaces, site preparation is usually very minimal that under-bridge spaces are reasonably flat in general. However, all under-bridge sites are different to some extent, boundary depth, structural bay width and bridge structure sizes. Therefore, the shape and size of the leftover spaces (circulation and other communal spaces) between the bridge structures and apartment units can be very different from site to site. However the use of material and structural system are standardized so that material can be reused or at least modified to suit the next site. All circulation and communal spaces are constructed of aluminum structures put together with nuts and bolts that can be dismantled and reassembled, in a similarly manner to steel scaffoldings. Structural spacing are kept to a standard span length, laid with plastic lumber decking based on its durability and reusability, and attached with fixing that do not require hole drilling. Other elements in these spaces, include balustrades, staircases and hydraulic elevators also are site-specific components but with minimum modifications to enable adoption to other sites. It is anticipated the concrete lift pit will be demolished when the housing system is moved.



Fig 69. Ground floor circulation space. Image by author.



Fig 70. First floor circulation space. Image by author.



Fig 71. Second floor circulation space. Image by author.

Vertical landscape

Since greenery and landscape are highly encouraged by the government, the harshness of the bridge super structure can be softened to create a more vibrant environment under the bridge. As the landscaping space is limited, the proposed solution suggests the use of vertical landscape system. These may have other benefits. As Ng suggests in his book *Design High-Density Cities for Social and Environmental Sustainability*, "A vertical landscape contributes to indoor air quality through generating oxygen and filtering air pollutants around the fresh air inlet."⁷⁷ The vertical landscape can be applied to the façades of the communal spaces around the bridge columns. Planter boxes are also introduced to the front of each apartment. Ng also cites that "According to species of plants, types of growing media and construction method, vertical green walls can be simply divided into three major categories as wall-climbing type, hanging-down type and module type."⁷⁸ The wall-climbing type is used at the communal spaces with mesh screening as growing support as well as for security purpose. The planter boxes will be planted with the hanging-down type as they are easier to maintain and will not obstruct the outlook view.

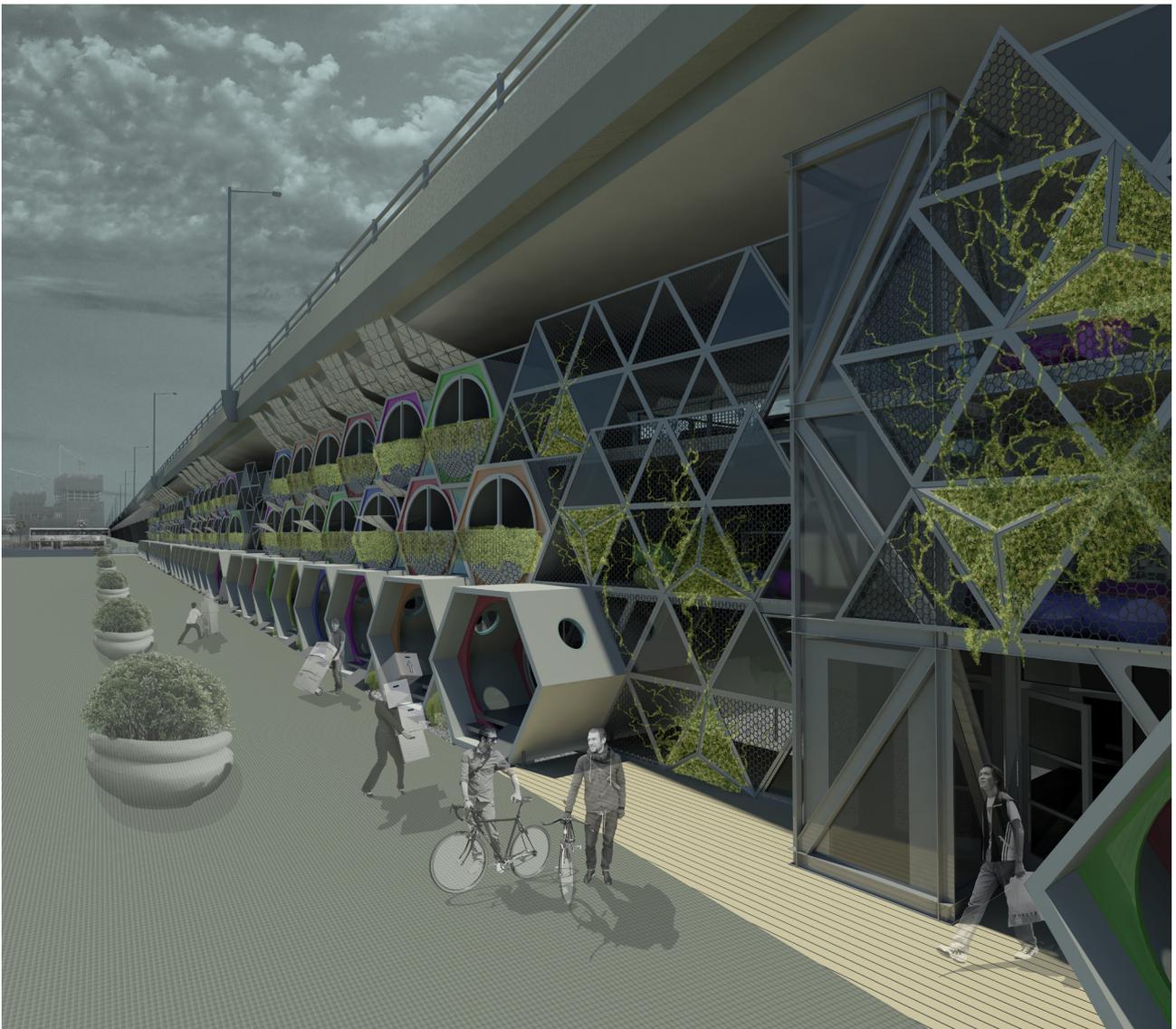


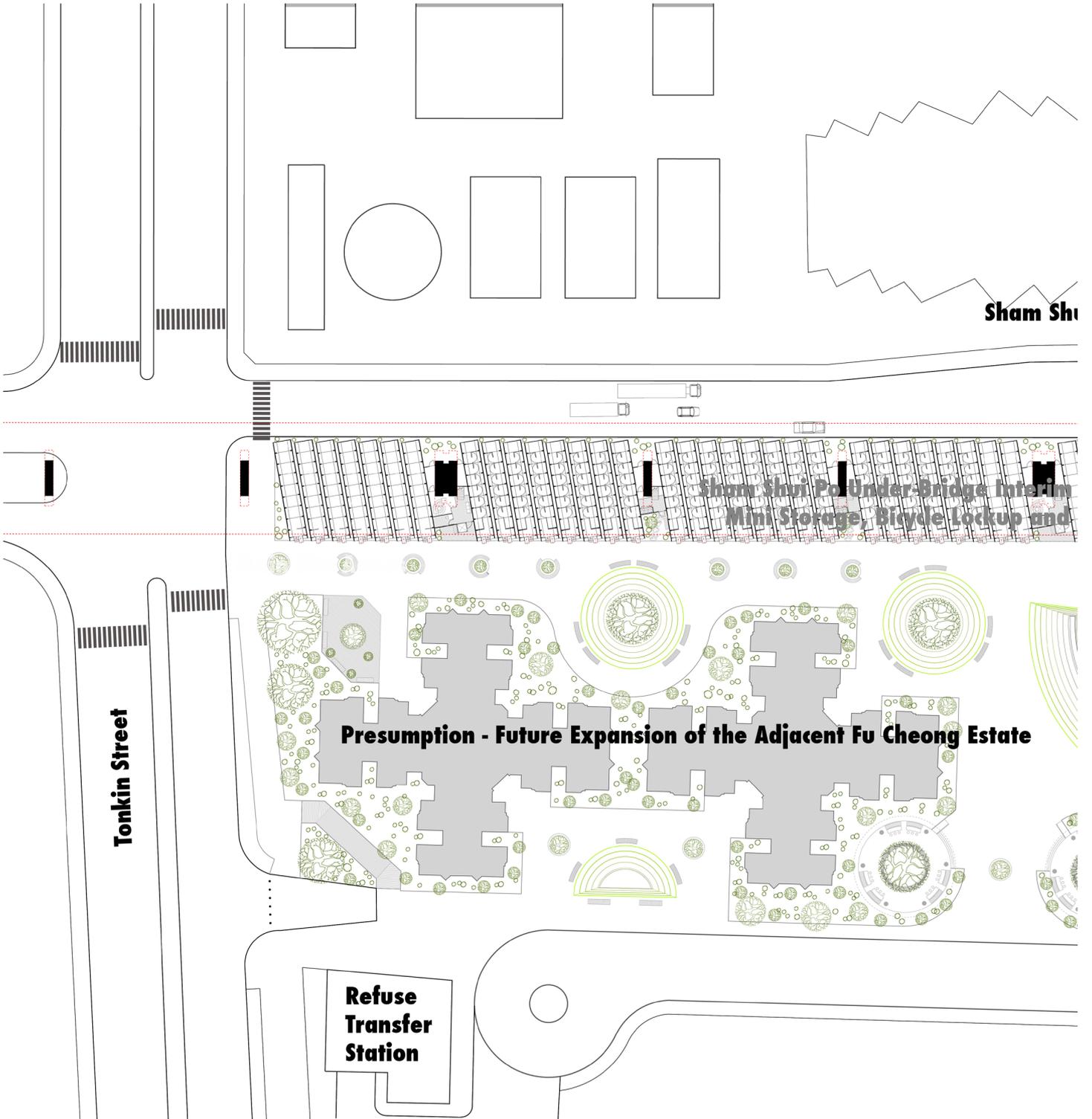
Fig 72. Vertical landscape. Image by author.

77 Ibid. P. 261.

78 Ibid. P. 258.

Conclusion

We hope this project will alert the authorities to the possibilities that under-bridge living can offer in the redevelopment of older towns in Hong Kong. It may seem overly positive in all these hopes, but one thing for sure, this demonstrate the possibility of under-bridge living to moderate the bad reputation of the Hong Kong's under-bridge spaces after Barrie Ho's approach with the Hong Kong Federation of Women T.S. Kwok Service Centre. This project is a remainder for the existence of the oblivious spaces, and attempts to resolve the provision of temporary housing only. There should be countless number of architectural opportunities from under-bridge spaces. Once there are more good examples established, "under-bridge architecture" may become a standard term in architectural language in densely populated cities.



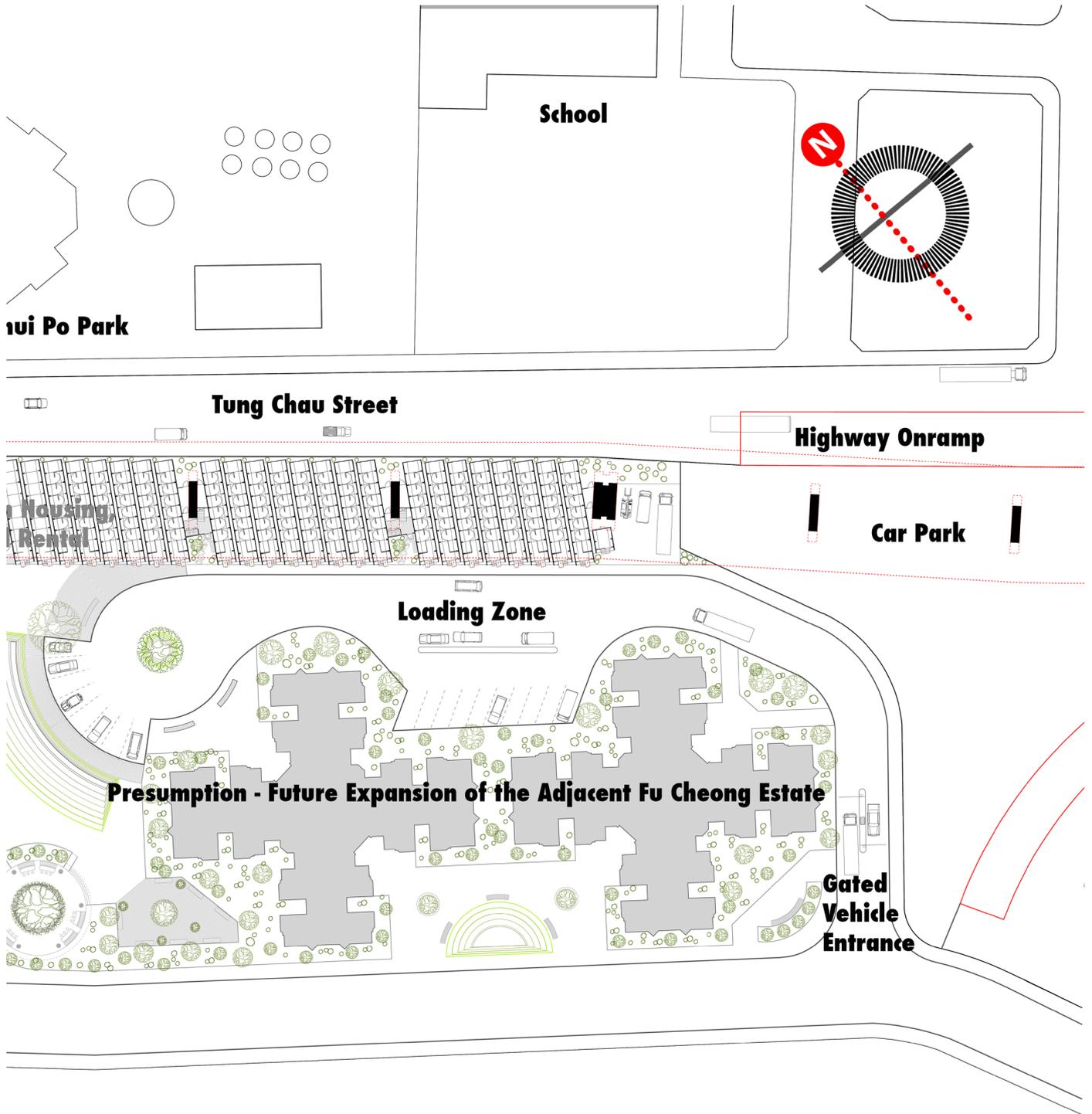


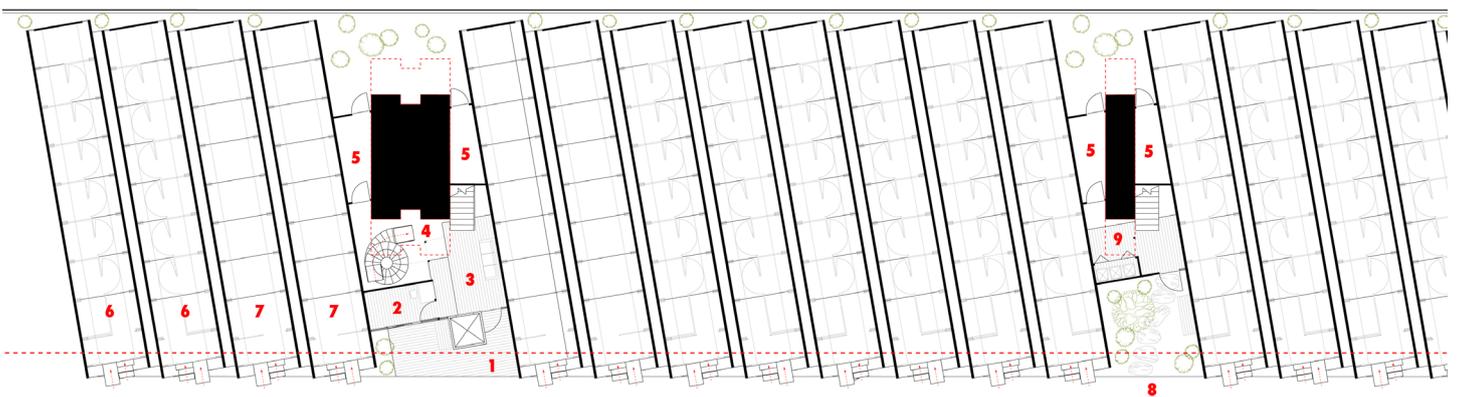
Fig 73. Site Plan. Illustration by author. Not in scale.



Second Floor Plan (Interchangeable Apartments)



First Floor Plan (Fixed Apartments)



Street Level Plan (Mini Storage, Bicycle Lockup & Rental)

- 1. Main Entrance**
- 2. Security Office**
- 3. Foyer**
- 4. Sandpit & Spiral Slide**
- 5. Services Control Room**
- 6. Mini Storage**
- 7. Bicycle Lockup**
- 8. Secondary Entrance & Fire Exit**
- 9. Refuse Collection Point**
- 10. Mini Storage Admin Office**
- 11. Site Parking (Telehandler)**
- 12. Kids' Play Area**
- 13. Four Modules Apartment**
- 14. Three Modules Apartment**
- 15. Two Modules Apartment**
- 16. Void**

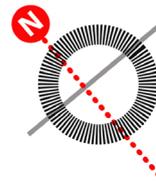


Fig 74. Floor Palms. Illustration by author. Not in scale.



Fig 75. View from Tonkin Street. Image by author.



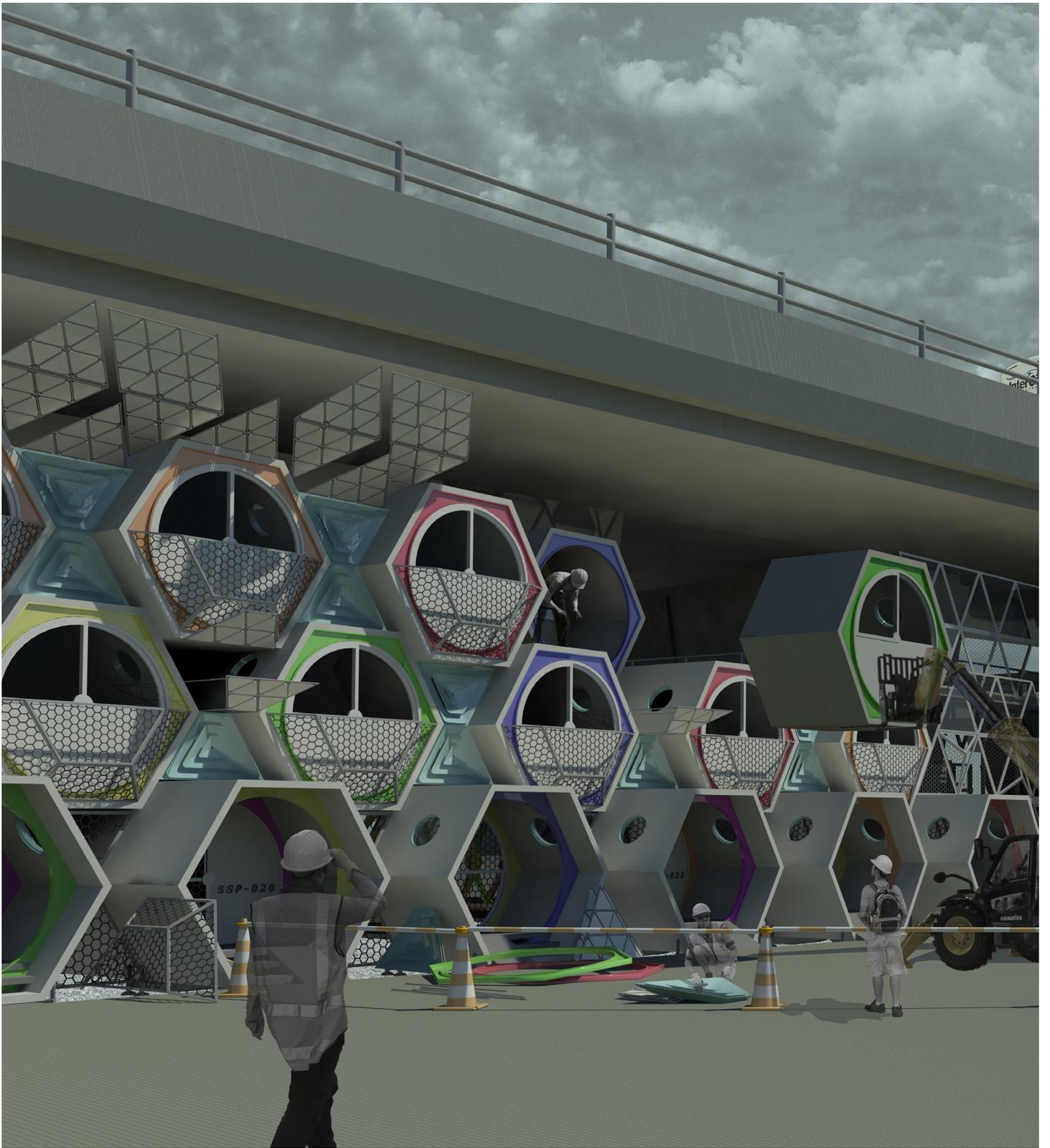




Fig 76. View of assemblage. Image by author.

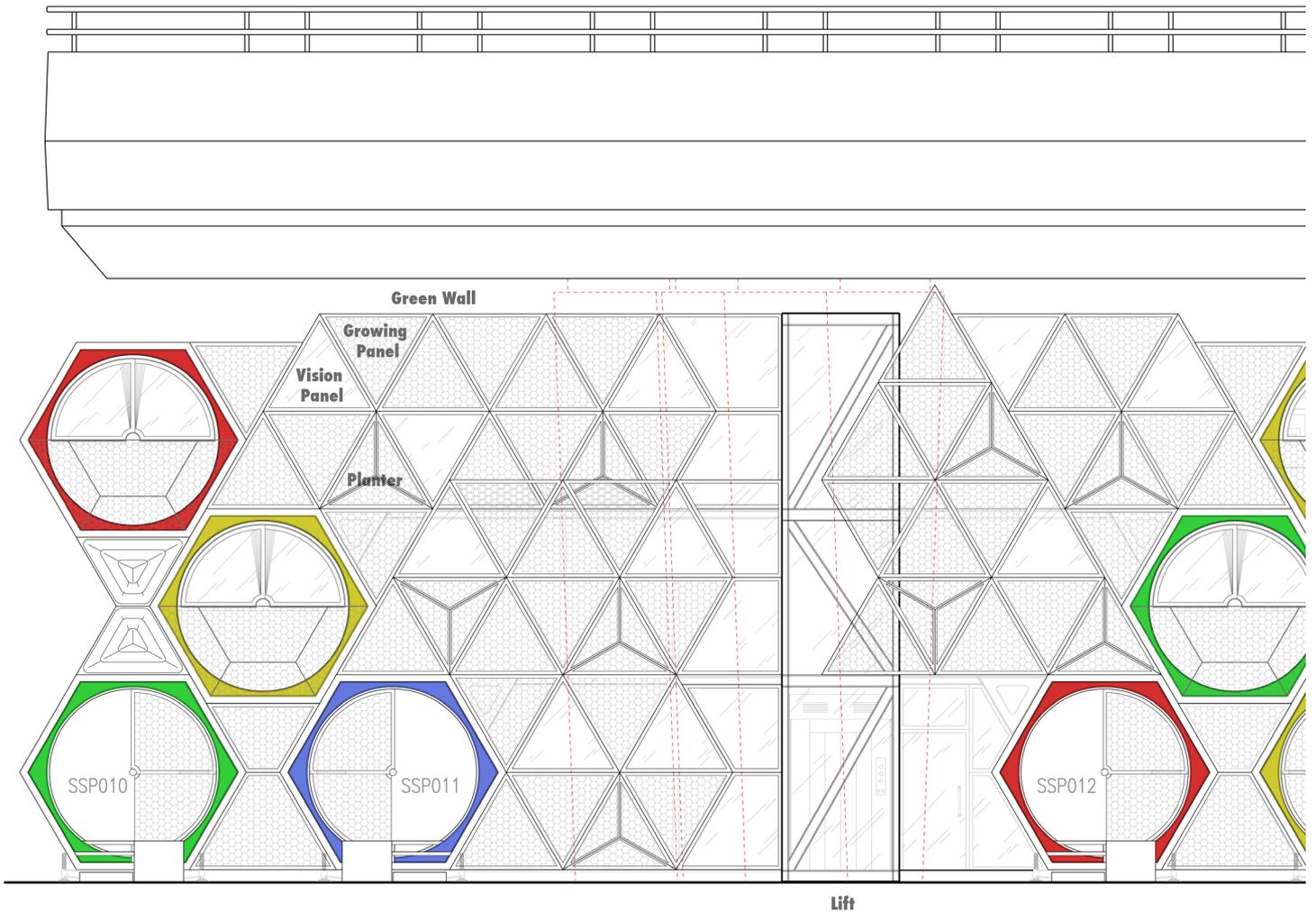
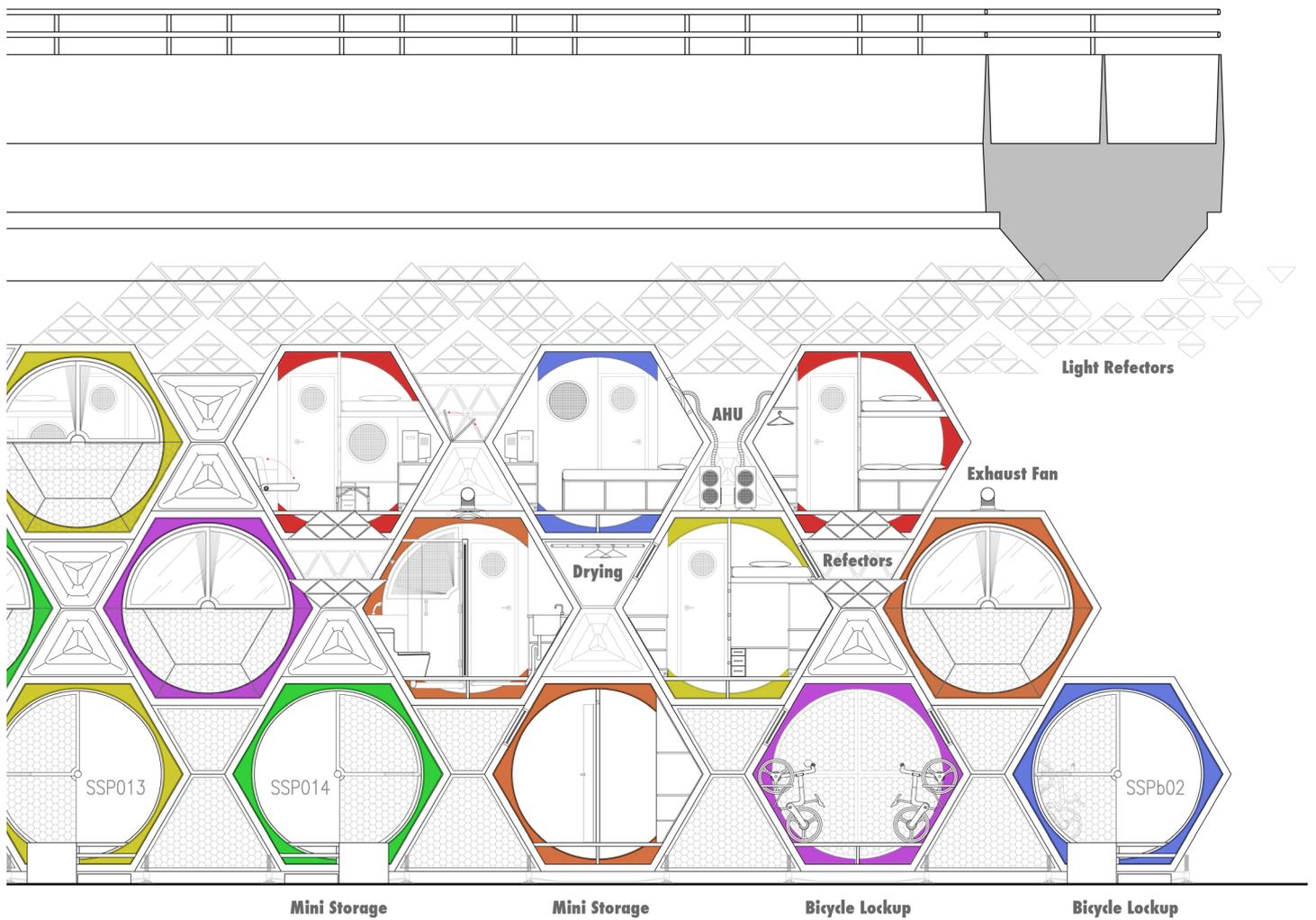


Fig 77. Cross-section/Elevation. Illustration by author. Not in scale.





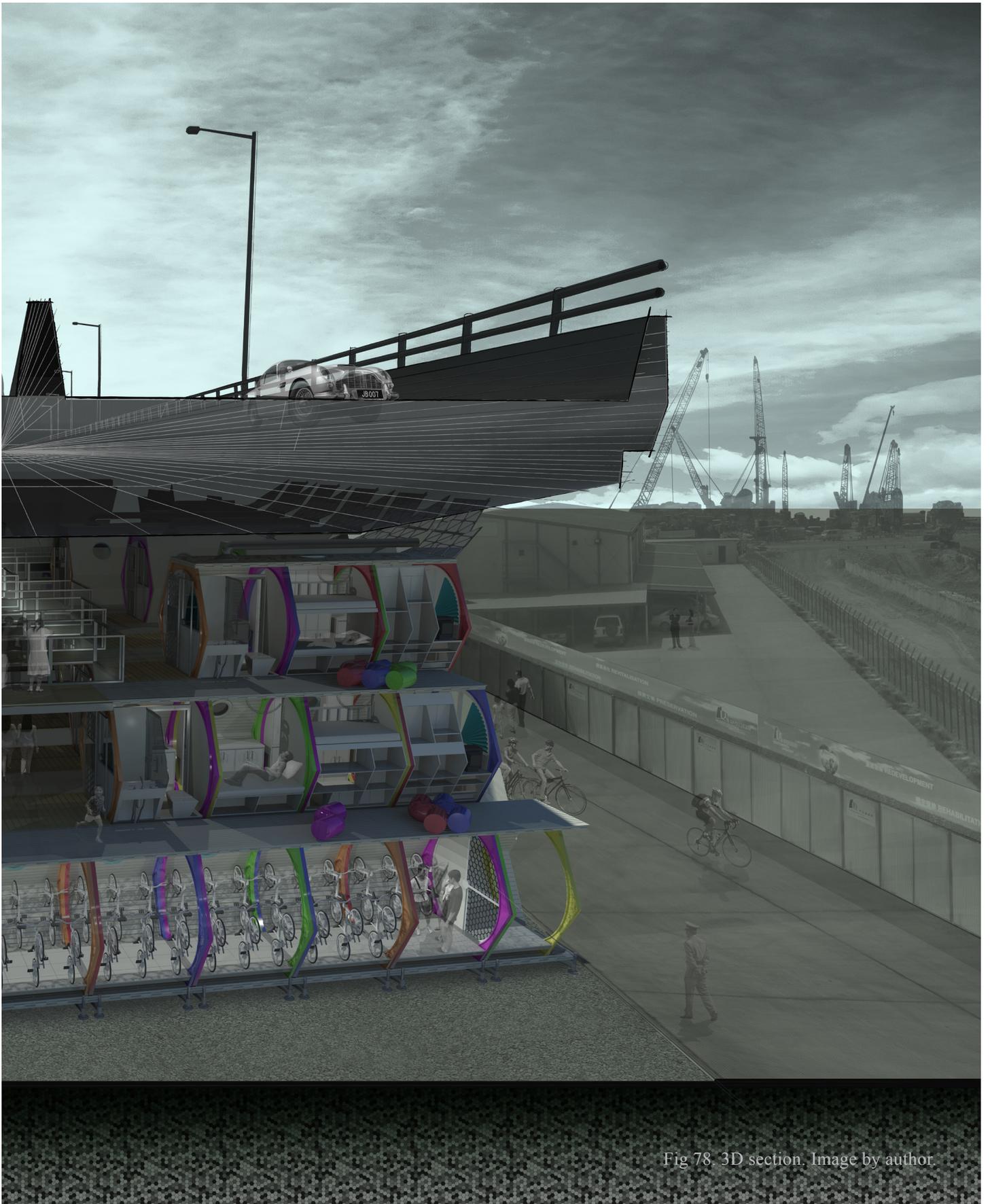
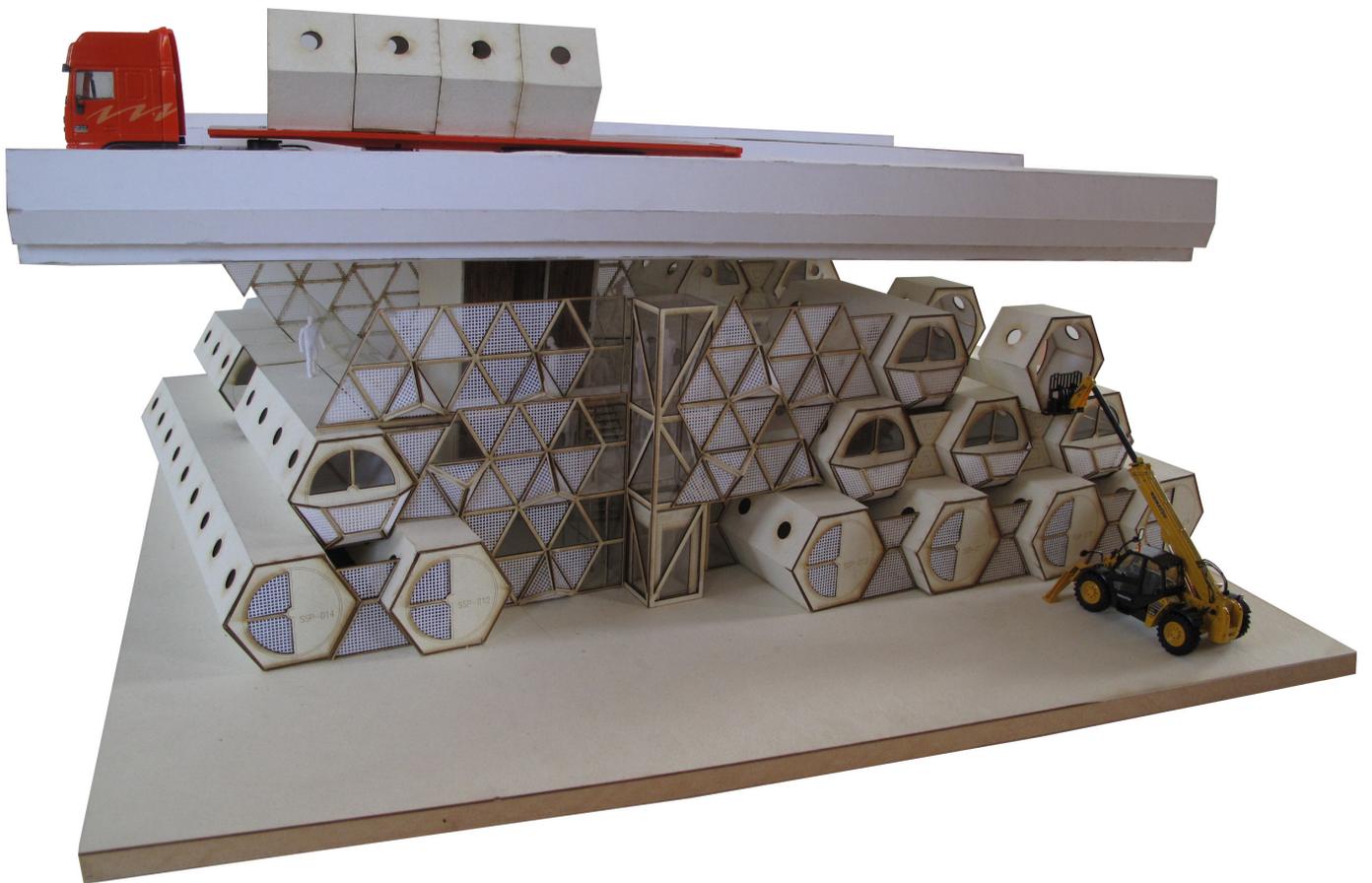
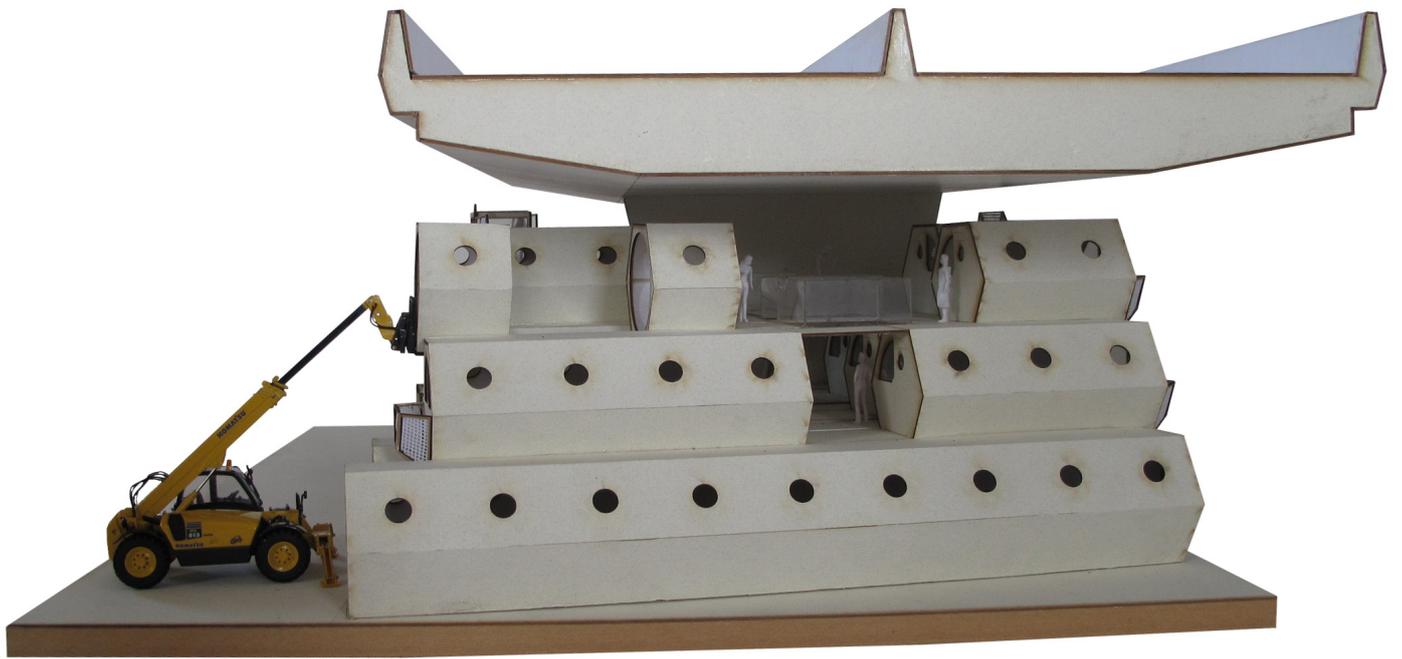


Fig 78. 3D section. Image by author.



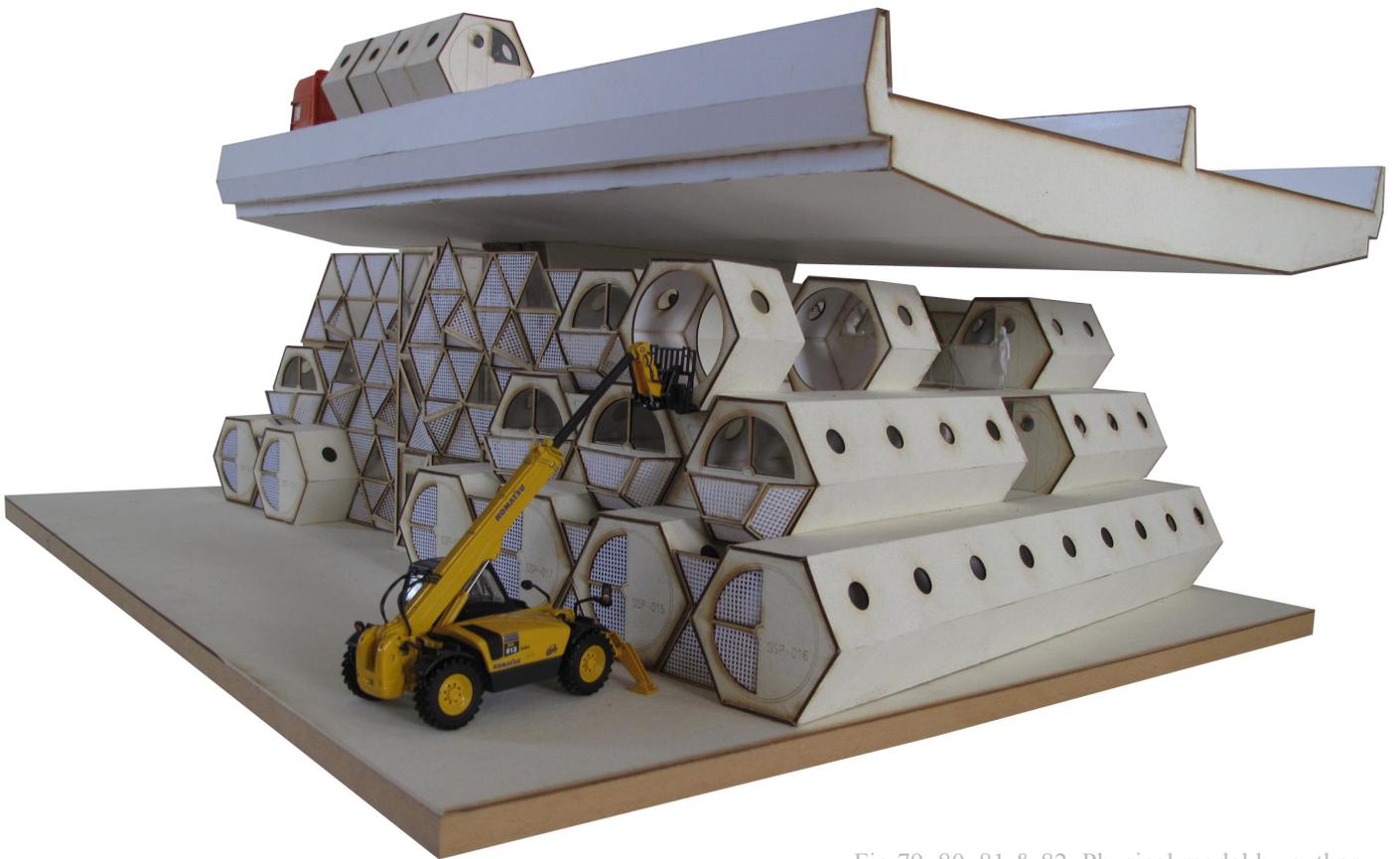
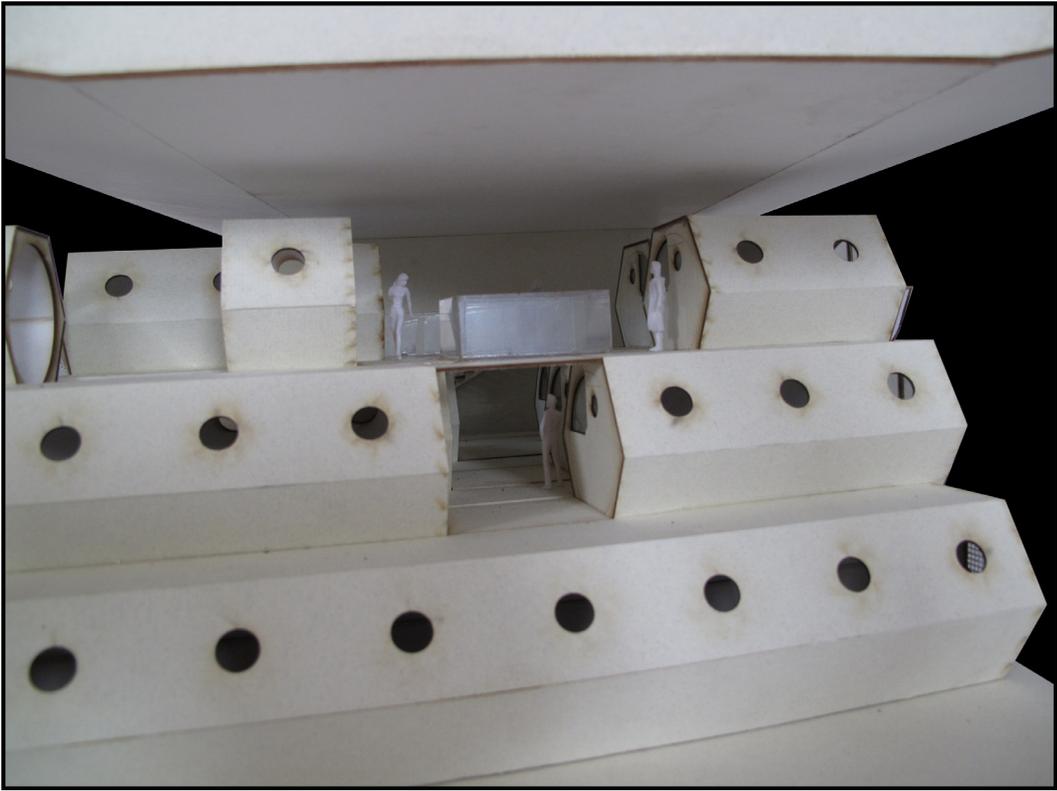


Fig 79, 80, 81 & 82. Physical model by author.

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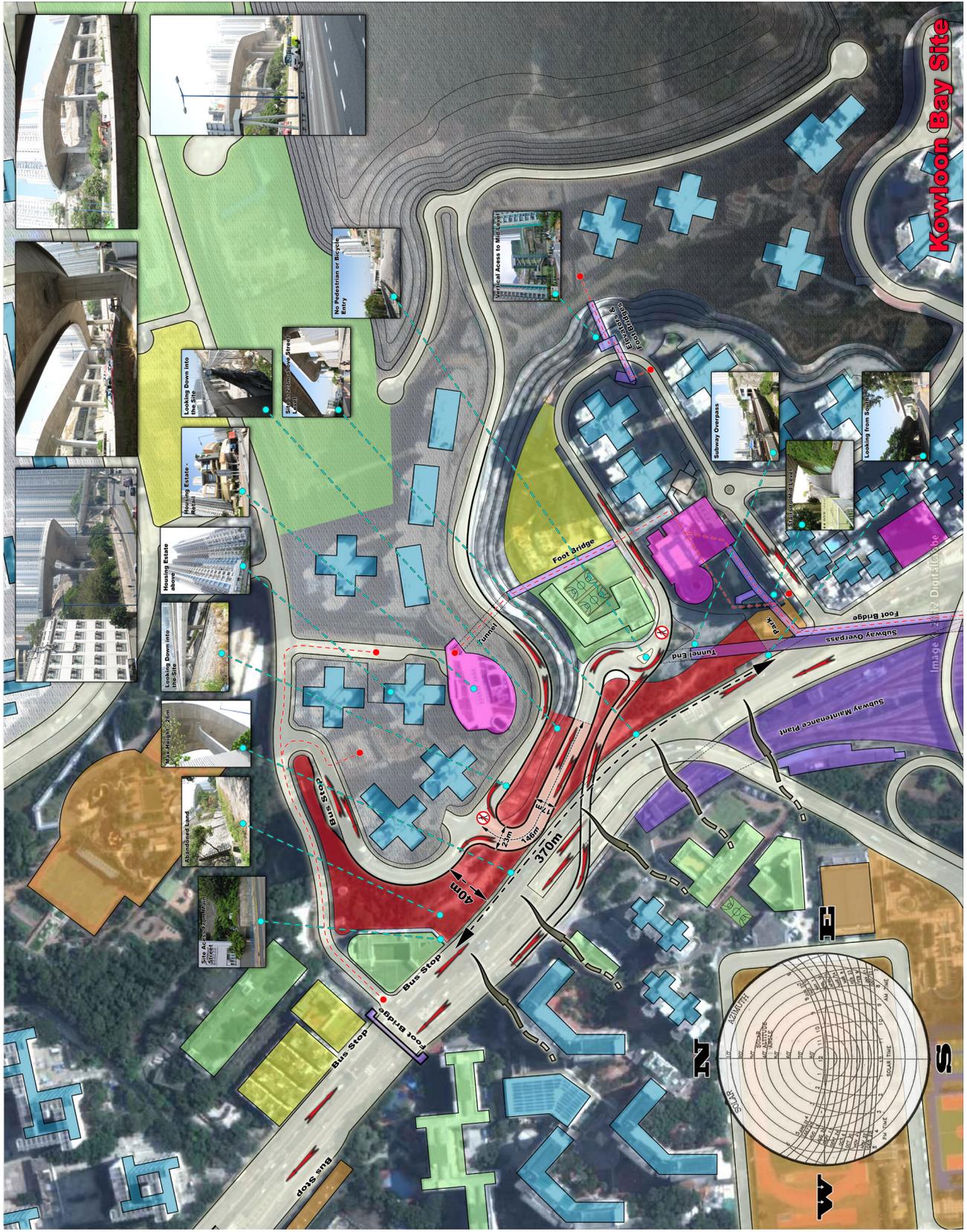
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Appendix

Site Analysis:



-  High Rise Housing
-  Low Rise Housing
-  School
-  Recreation & Park
-  Commercial & Industrial
-  Old Airport to be Developed
-  Transportation Terminal
-  Main Traffic Route
-  SITE



- 

High Rise Housing
- 

Low Rise Housing
- 

School
- 

Recreation & Park
- 

Main Retail
- 

Transportation
- 

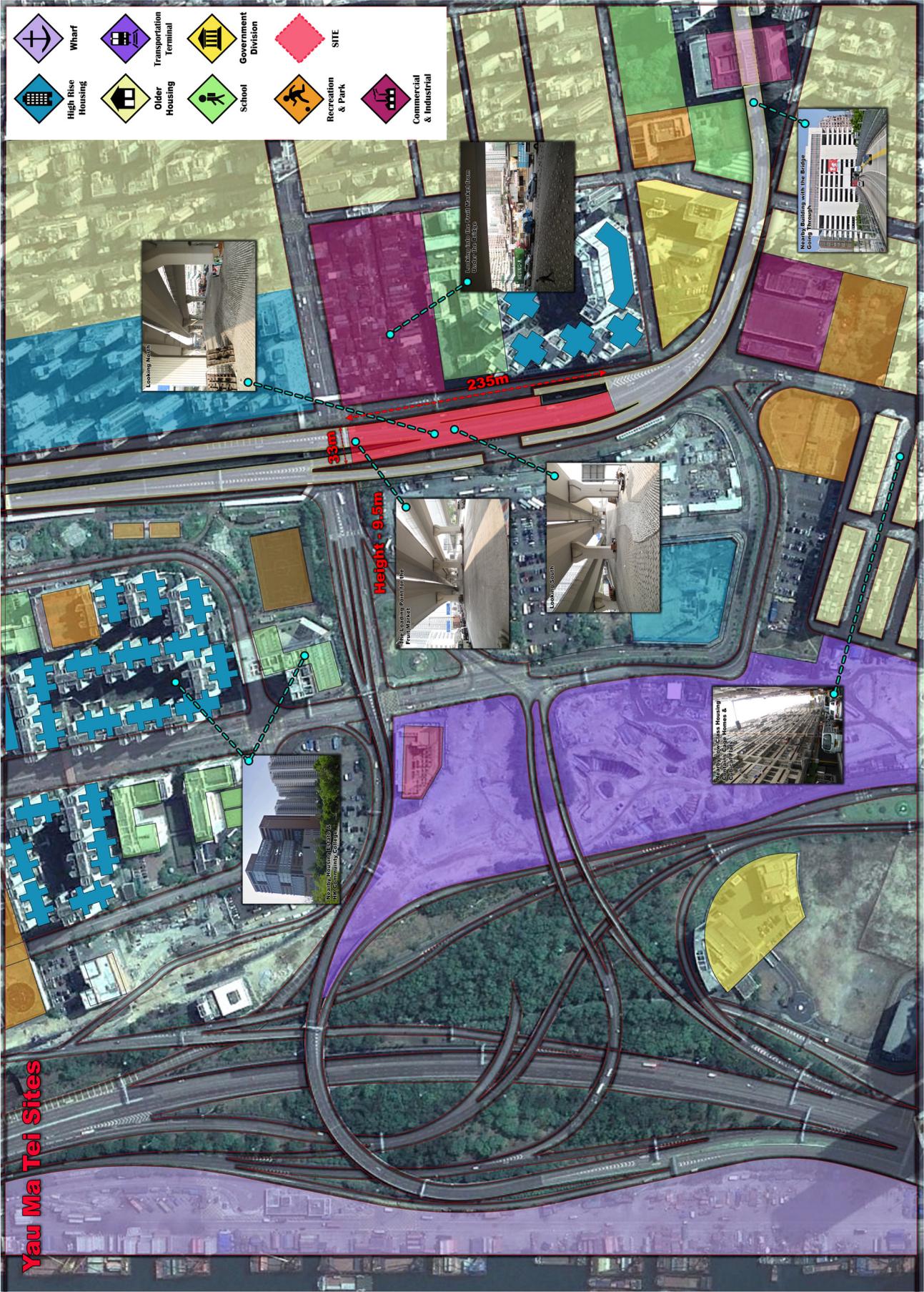
SITE
- 

Mid-Level
- 

Route to Upper Housing Estate
- 

Main Noise & Air Pollution

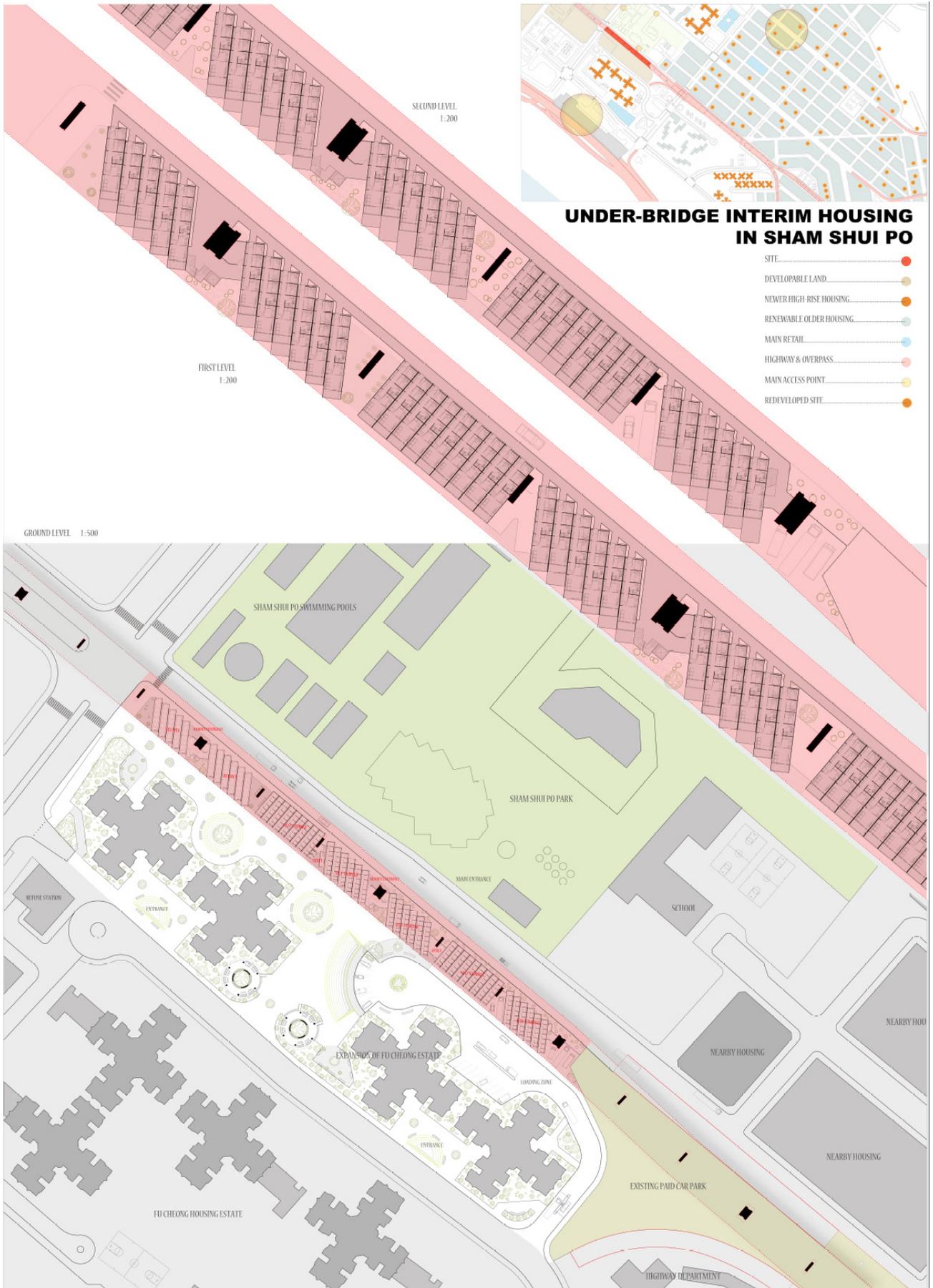
Yau Ma Tei Sites



Tsuen Wan Sites



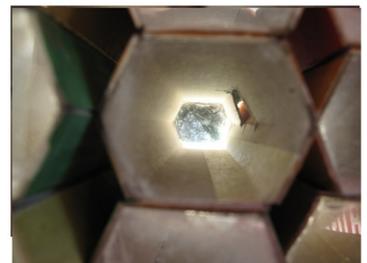
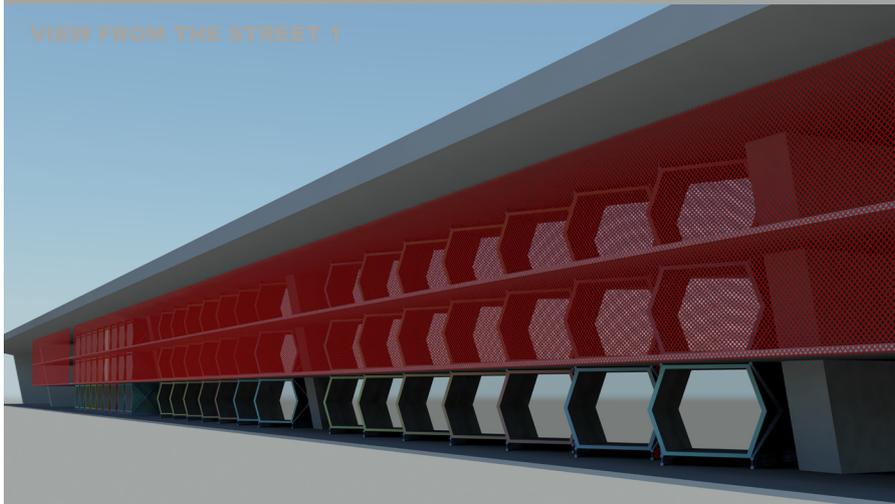
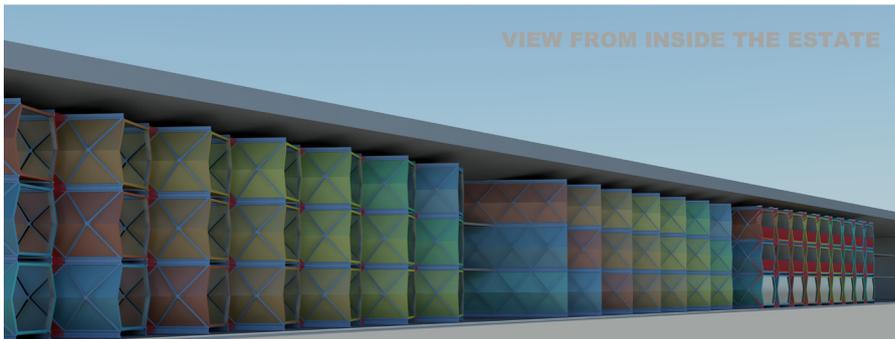
First Crit:



UNDER-BRIDGE INTERIM HOUSING IN SHAM SHU PO

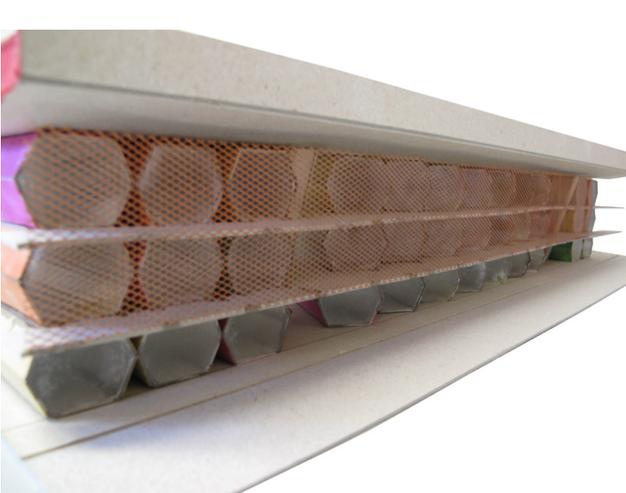


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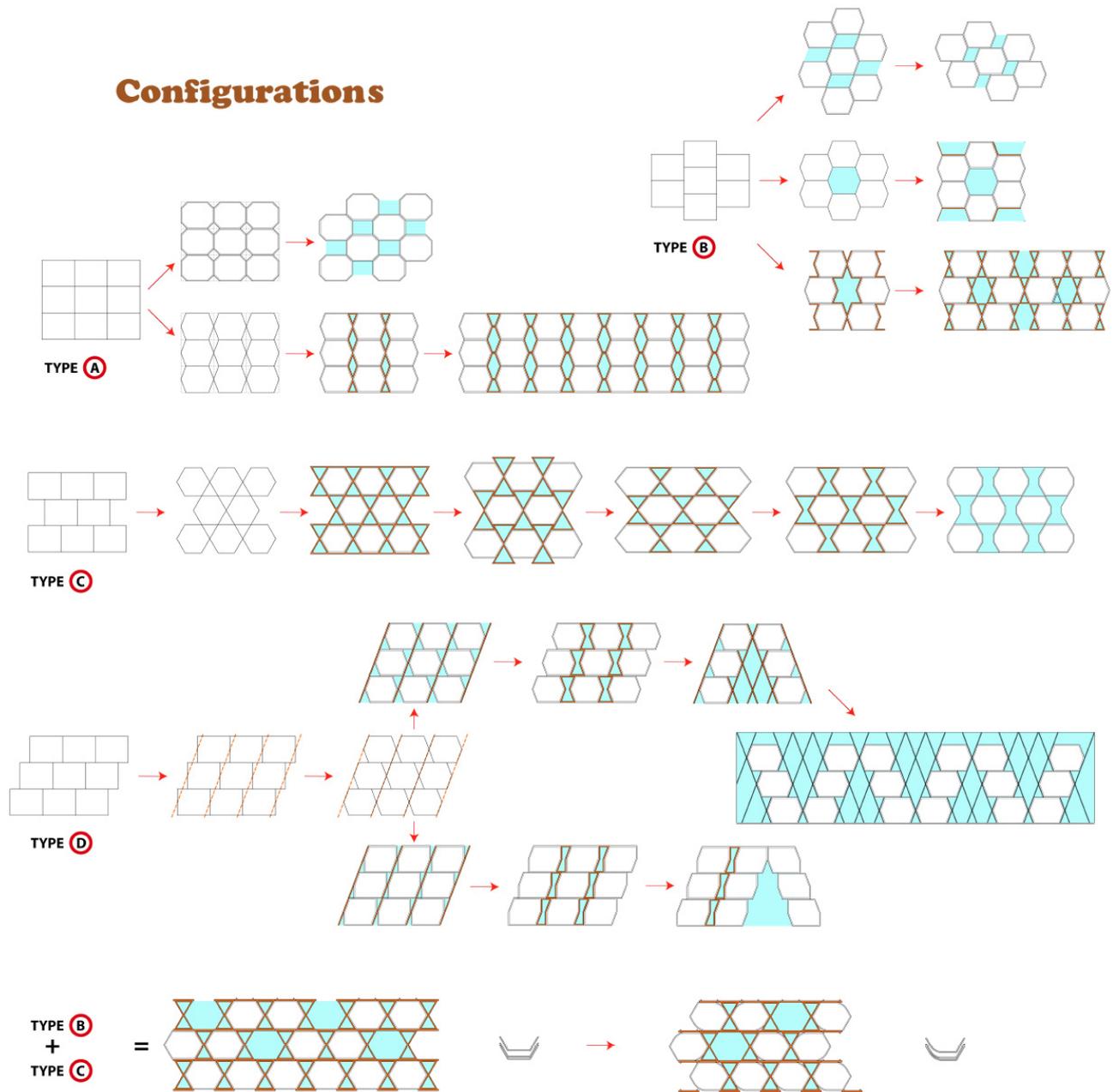


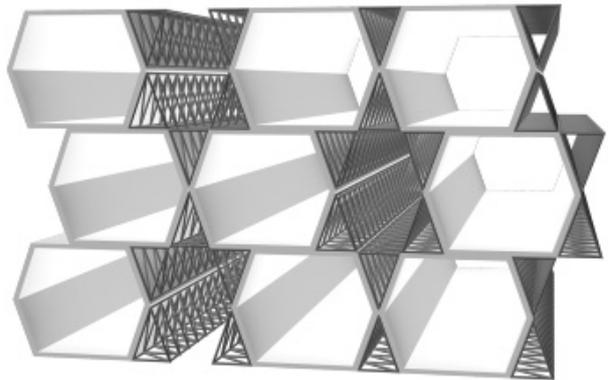
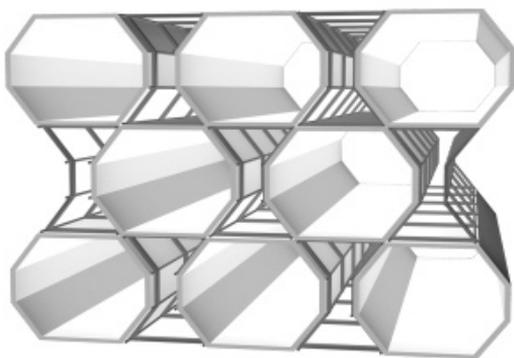
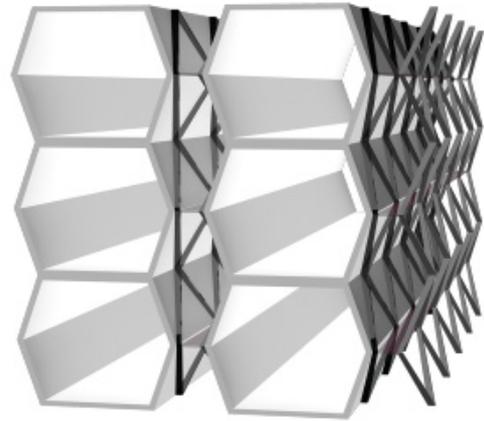
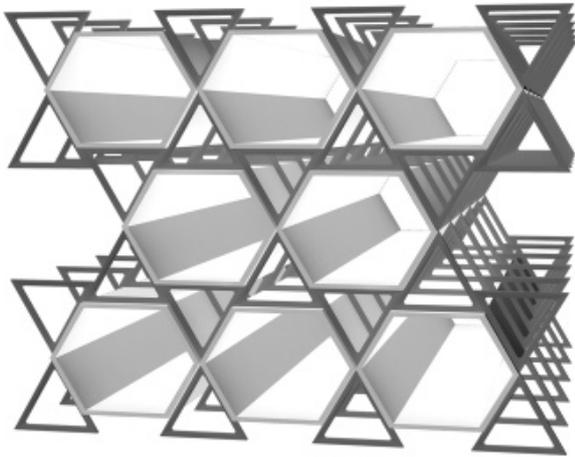
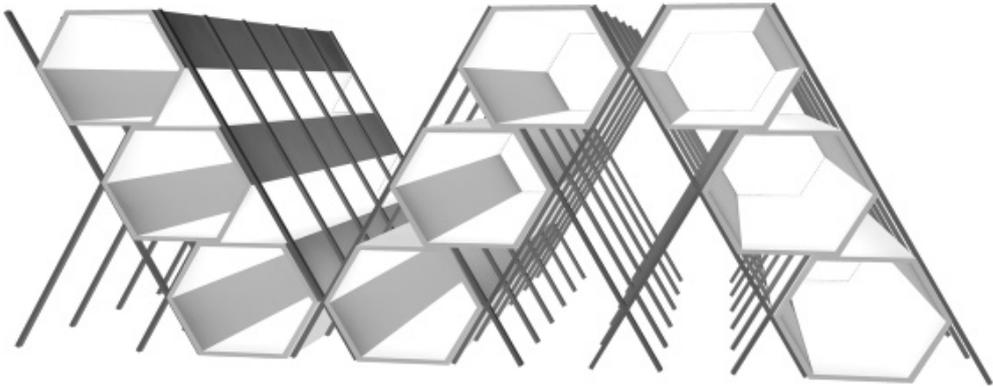
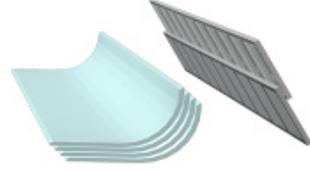
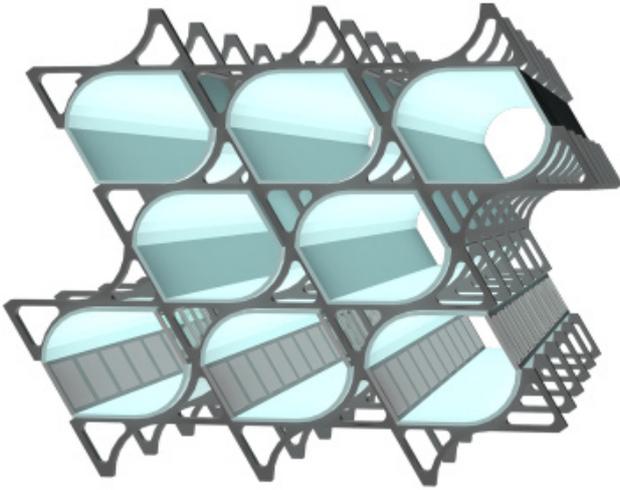
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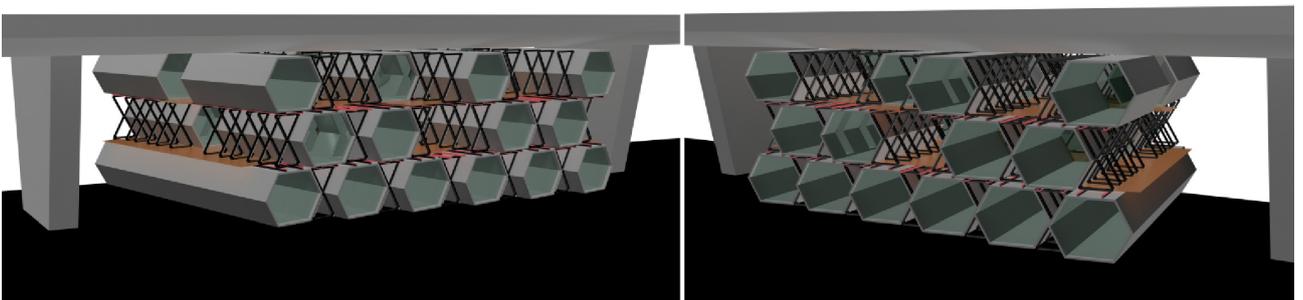
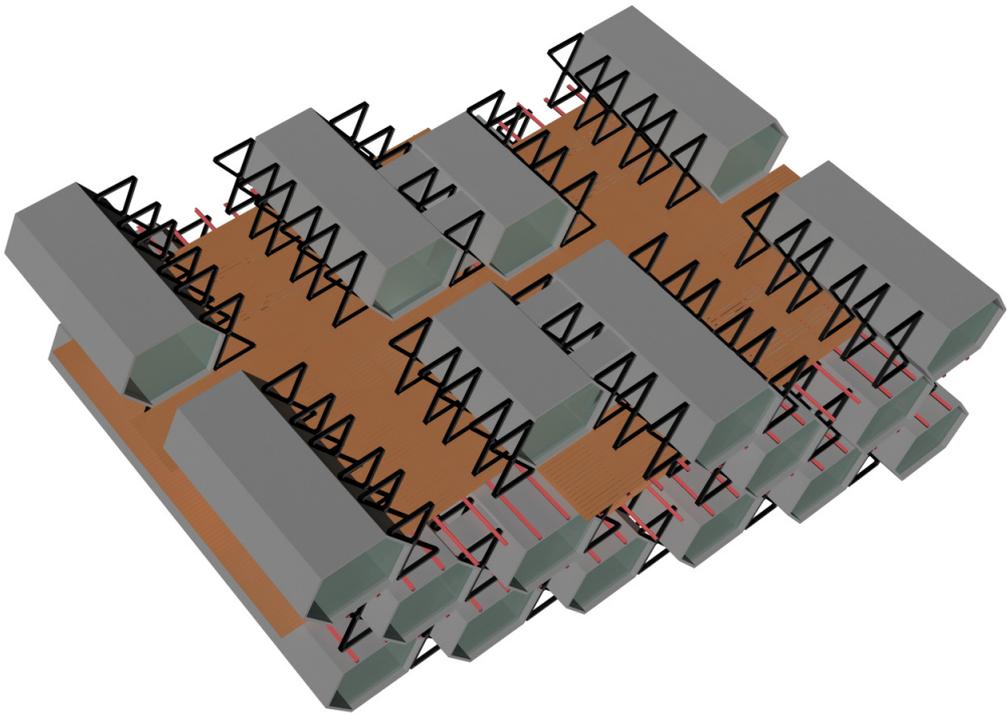
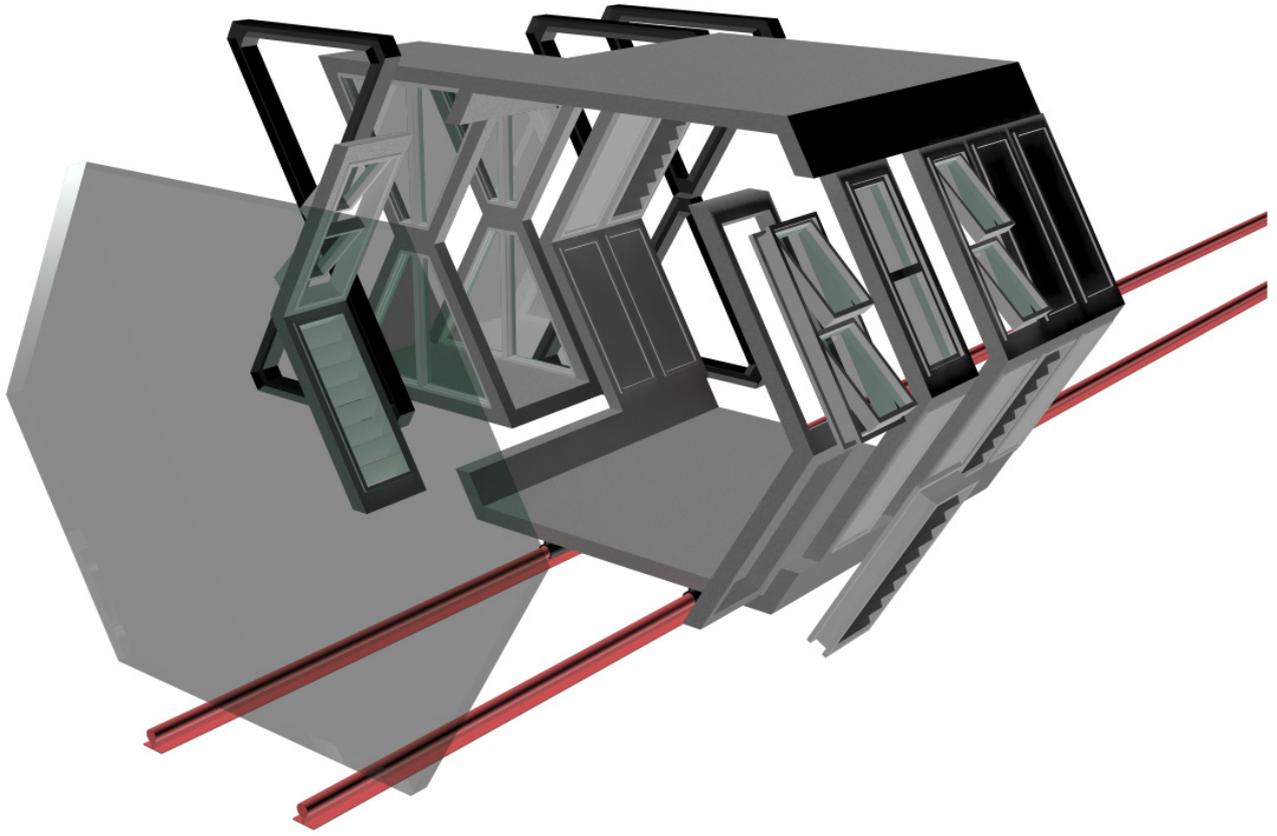


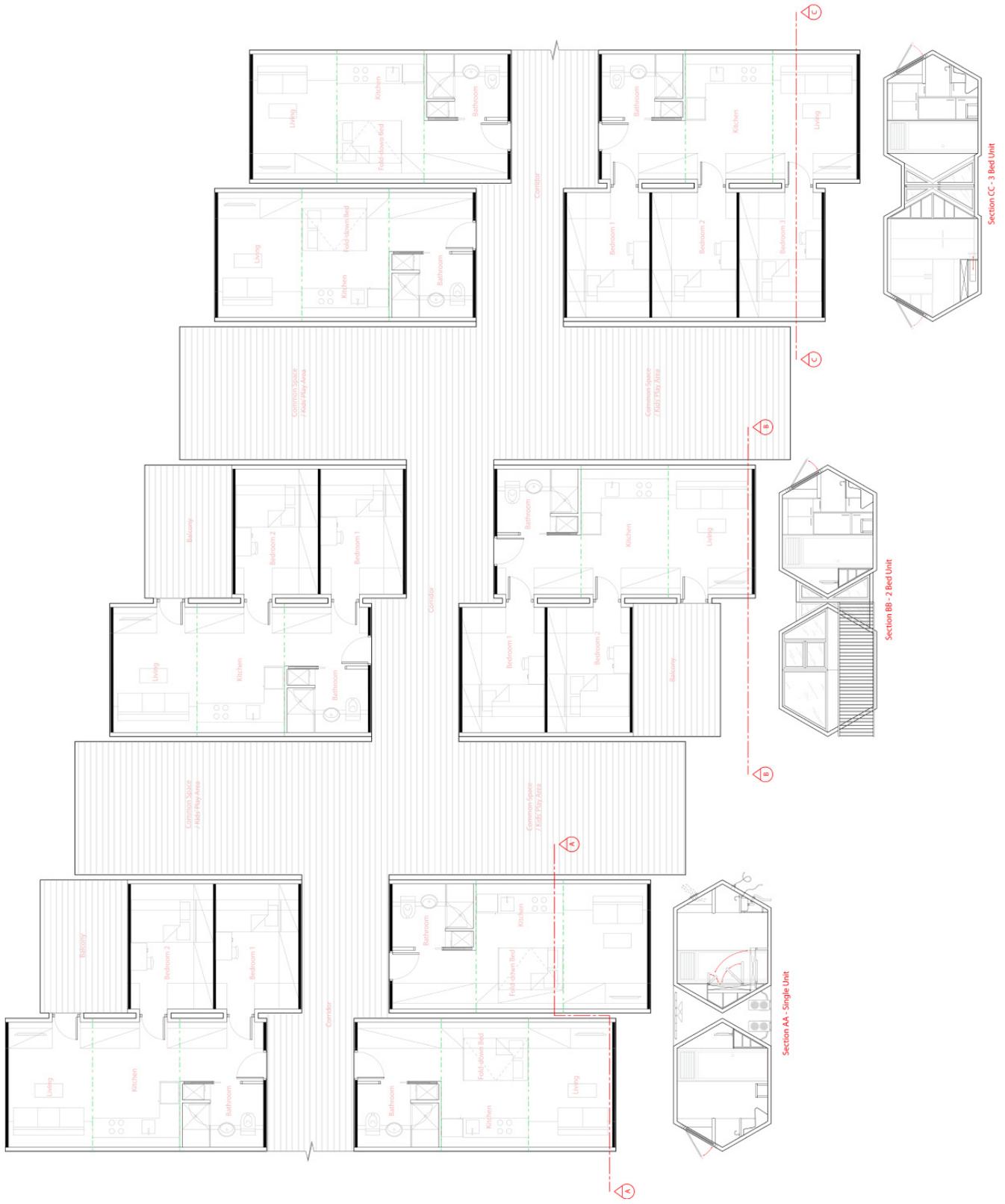
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Configurations

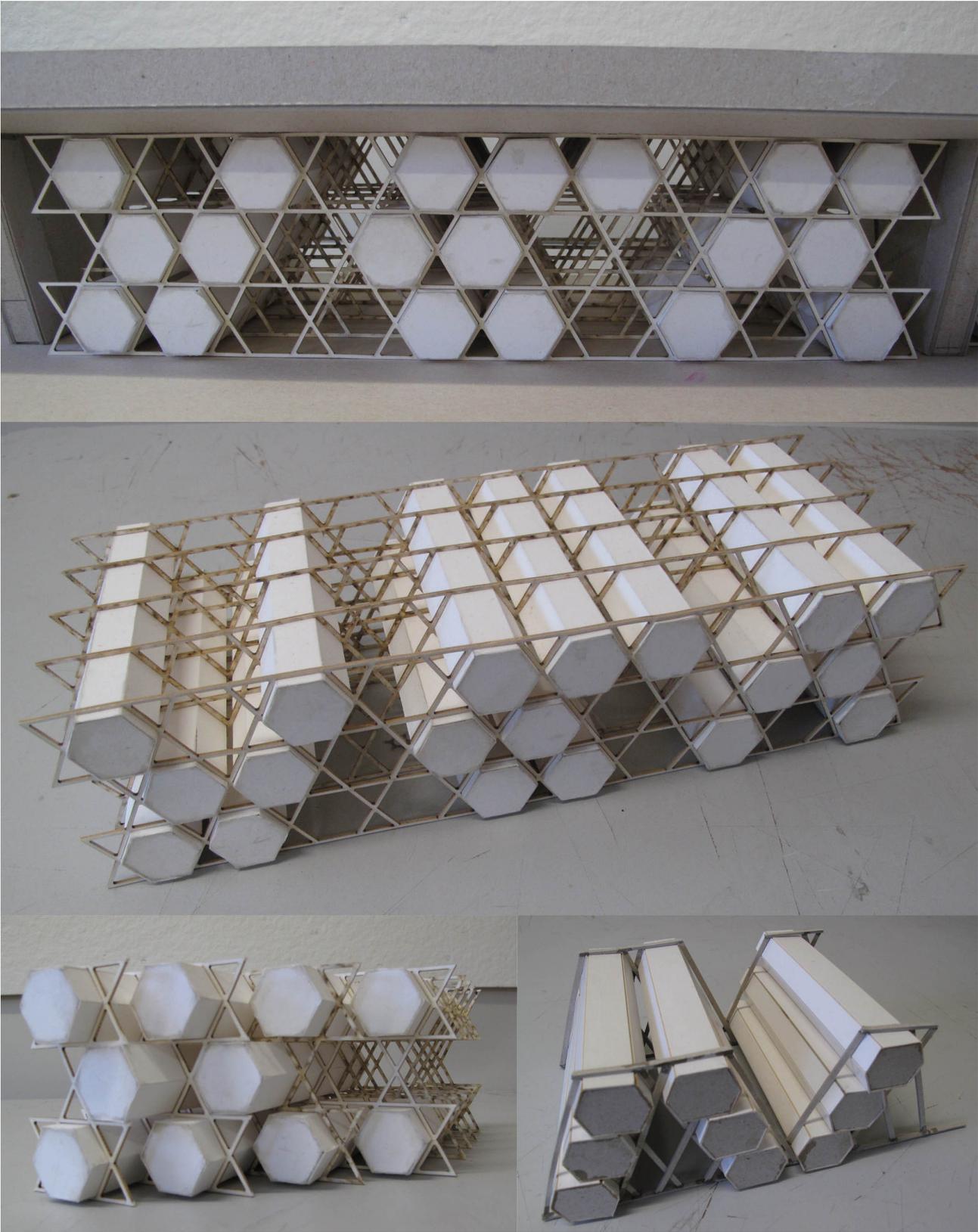




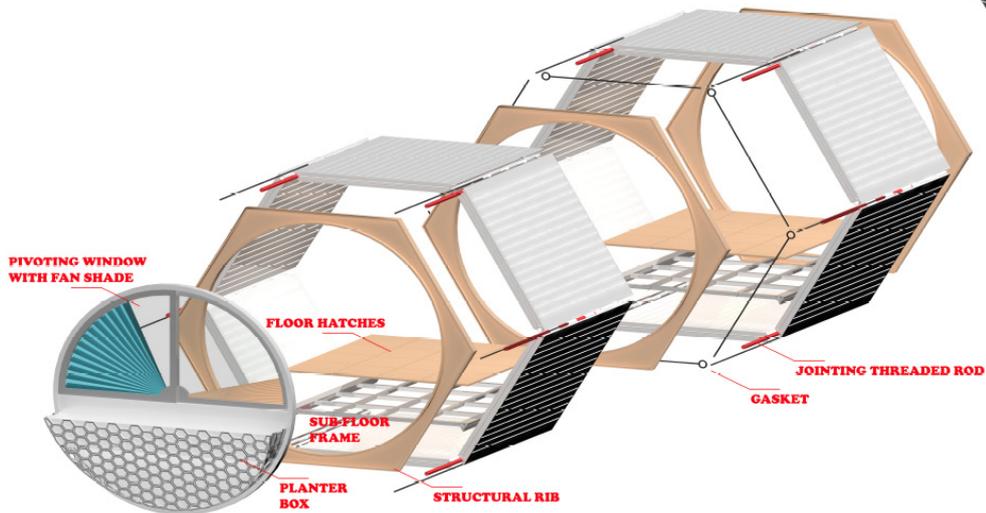
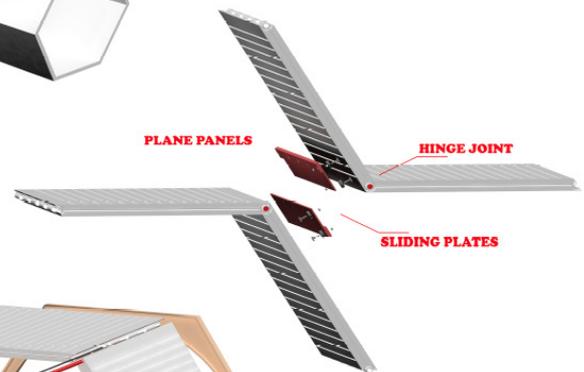
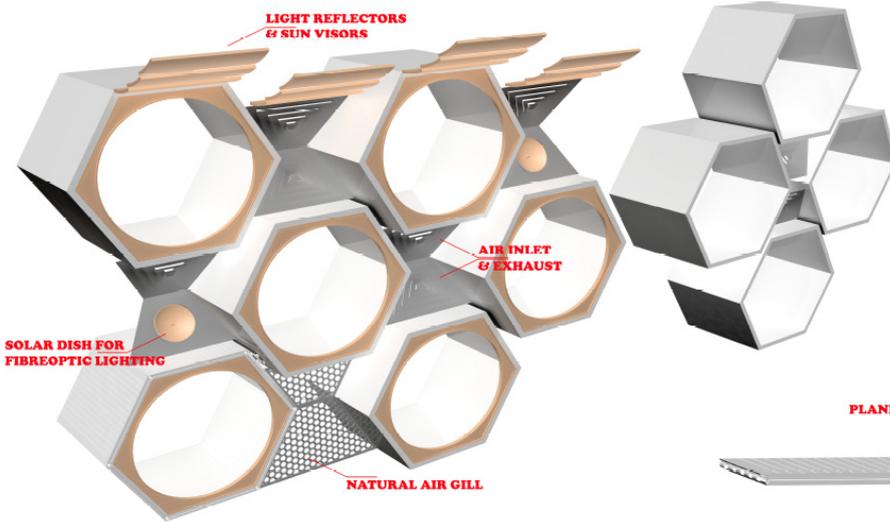
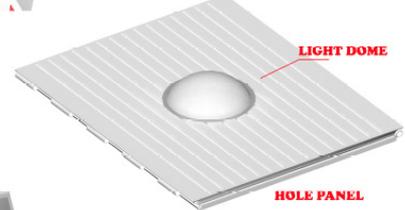
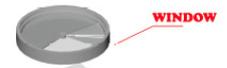
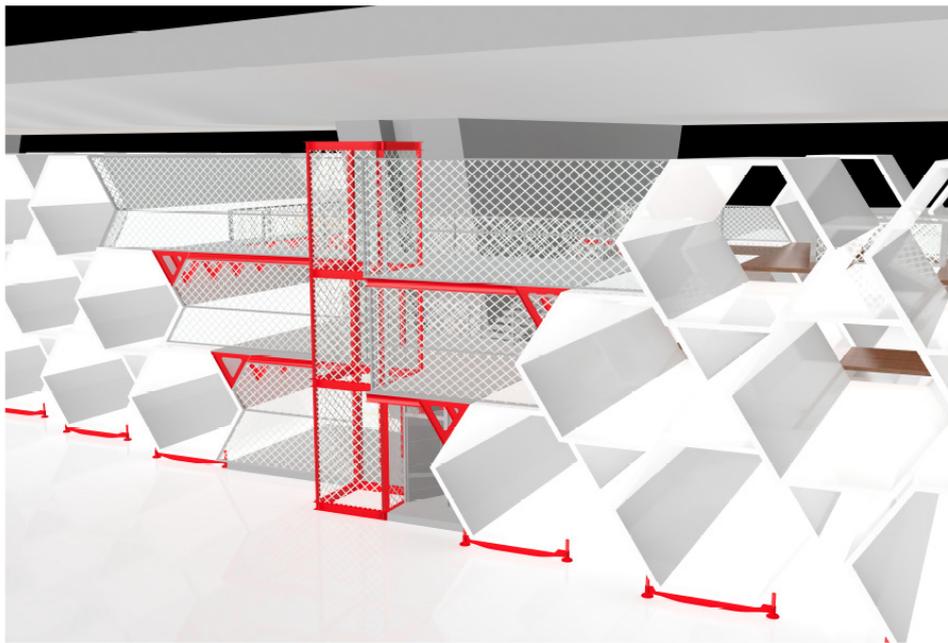


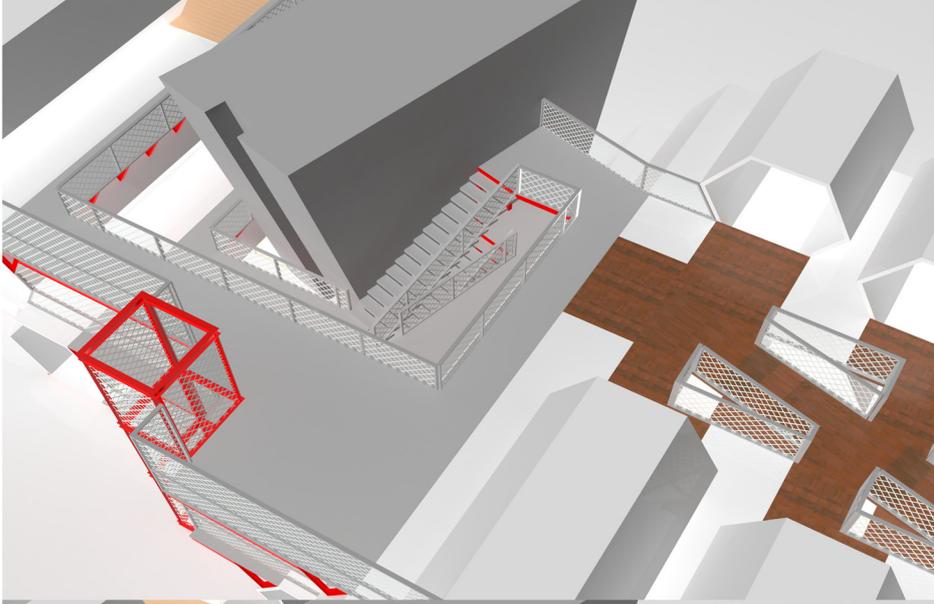


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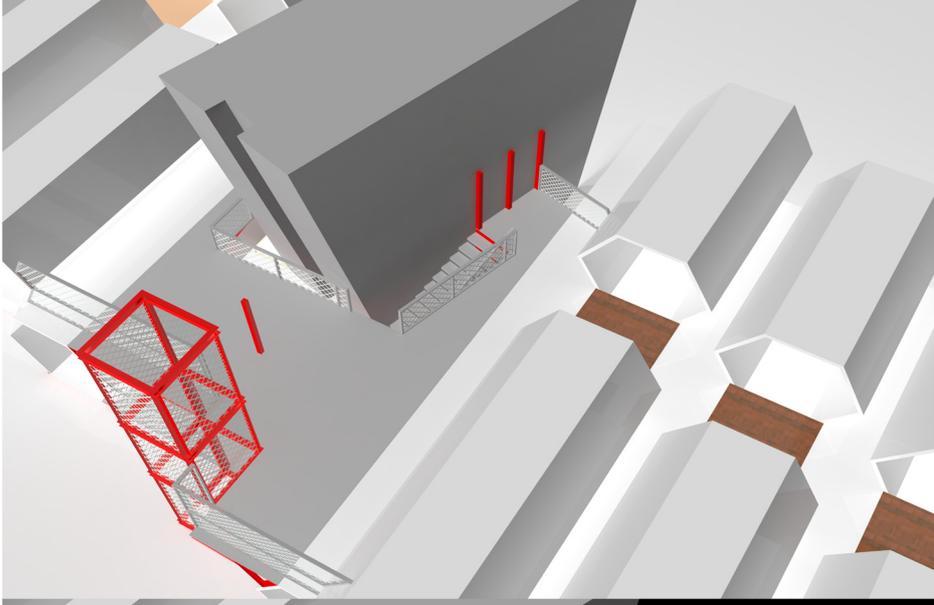


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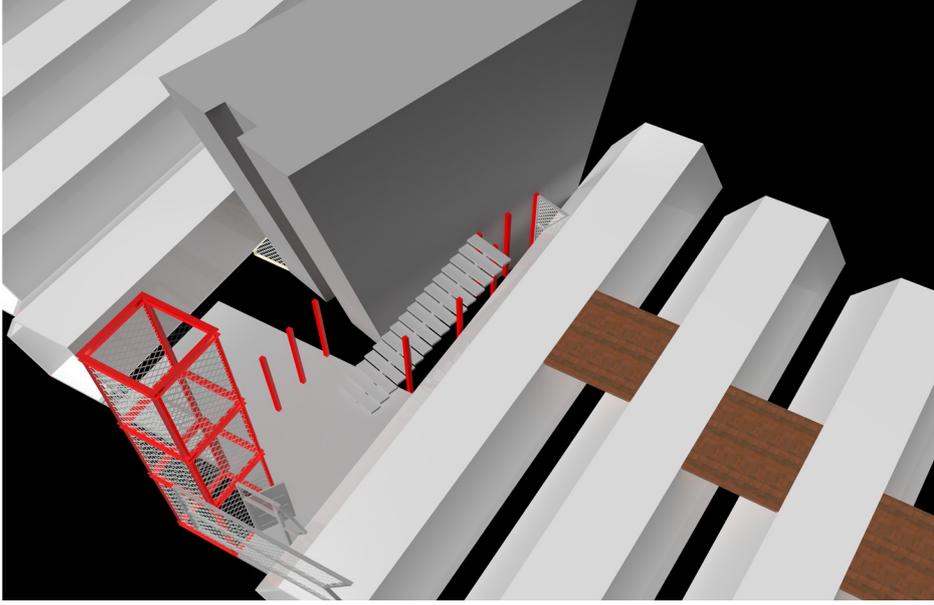




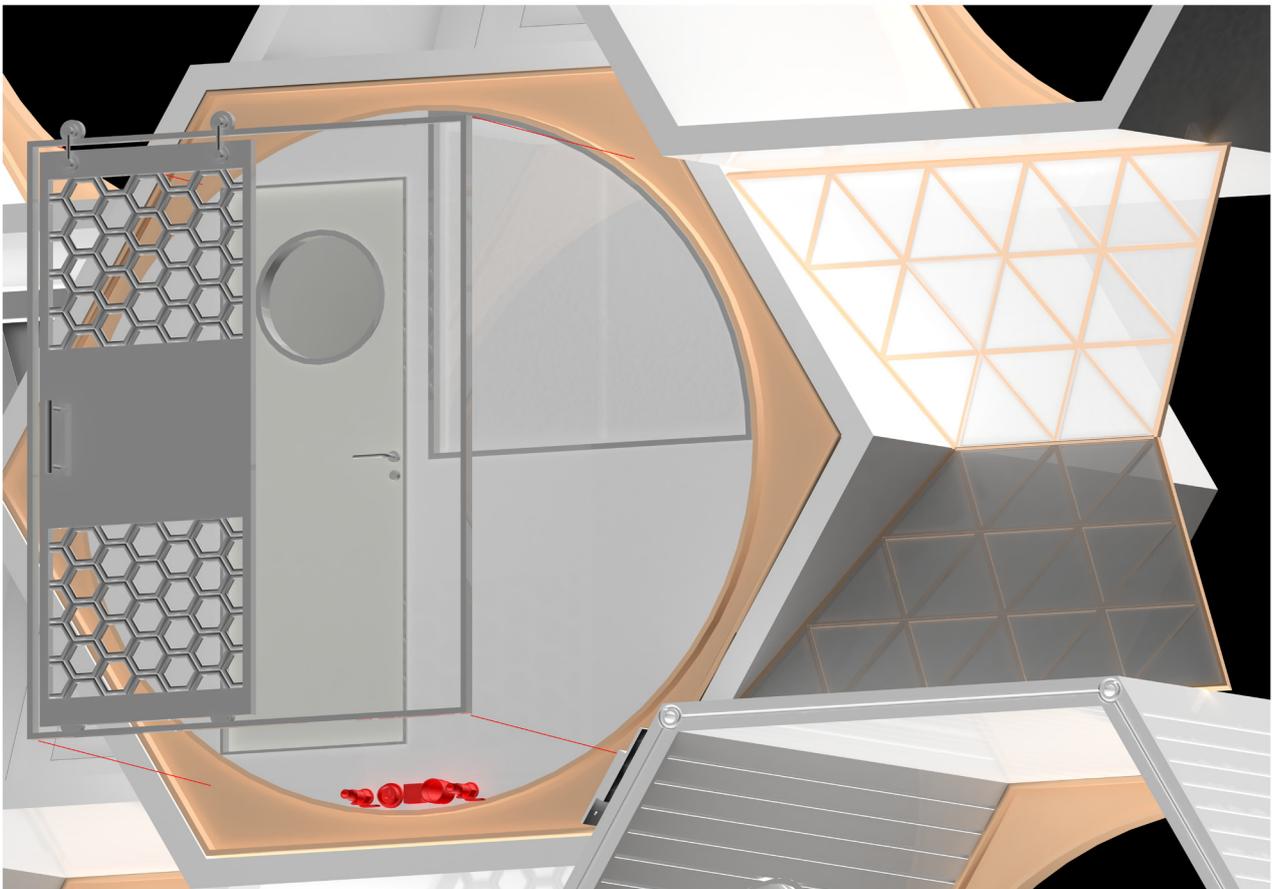
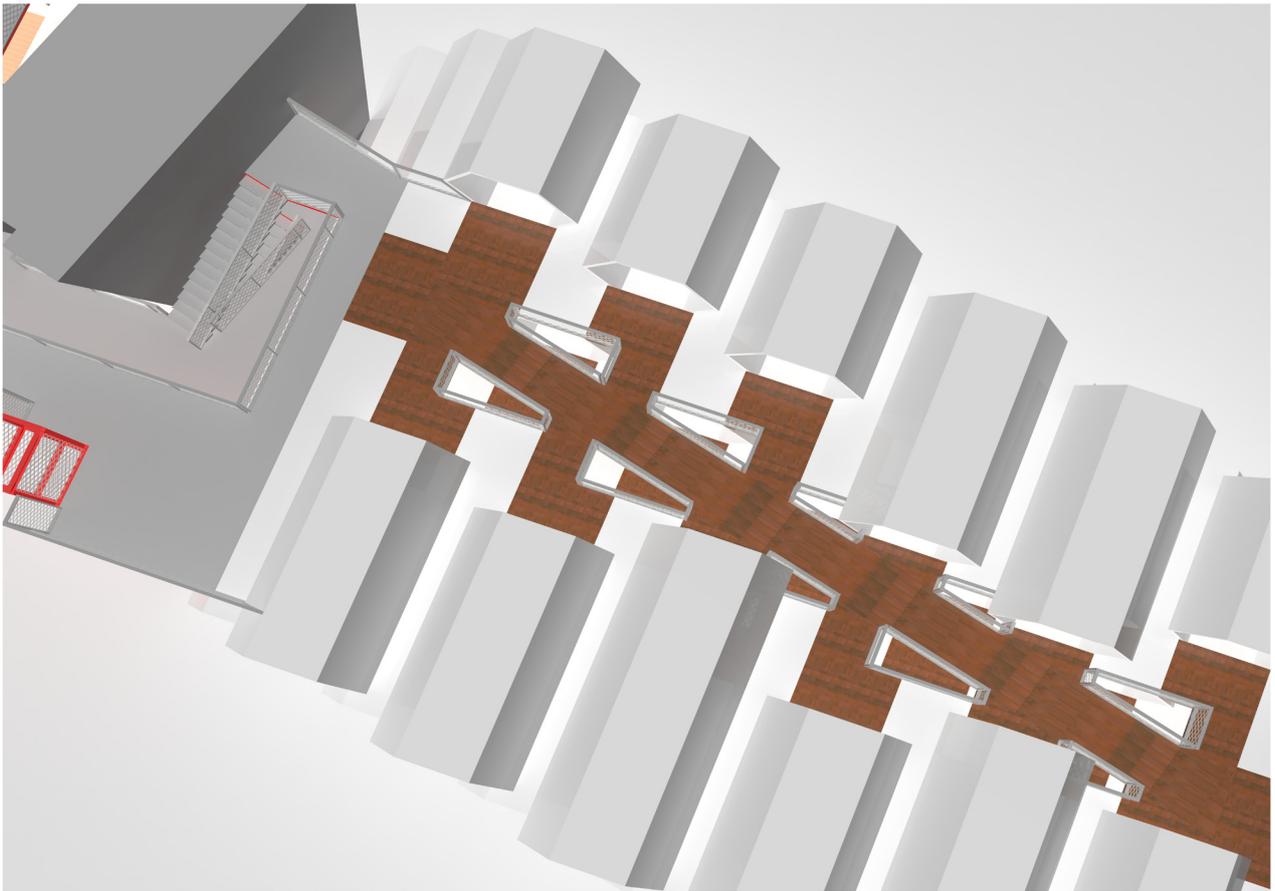
SECOND



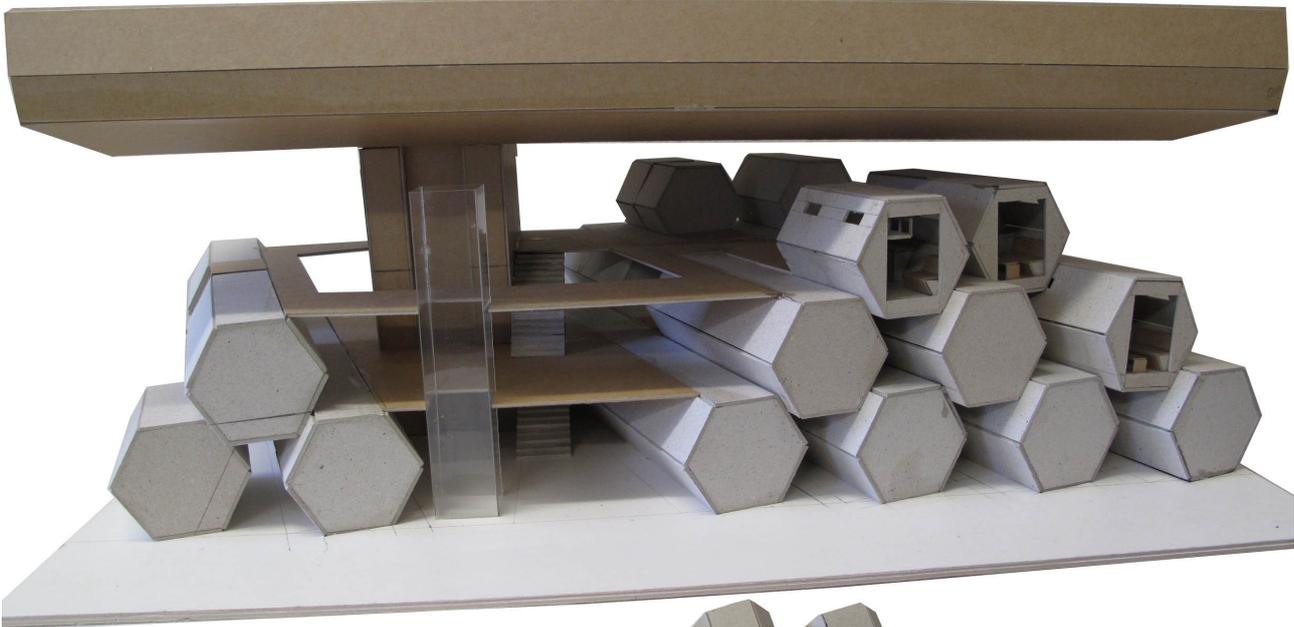
FIRST

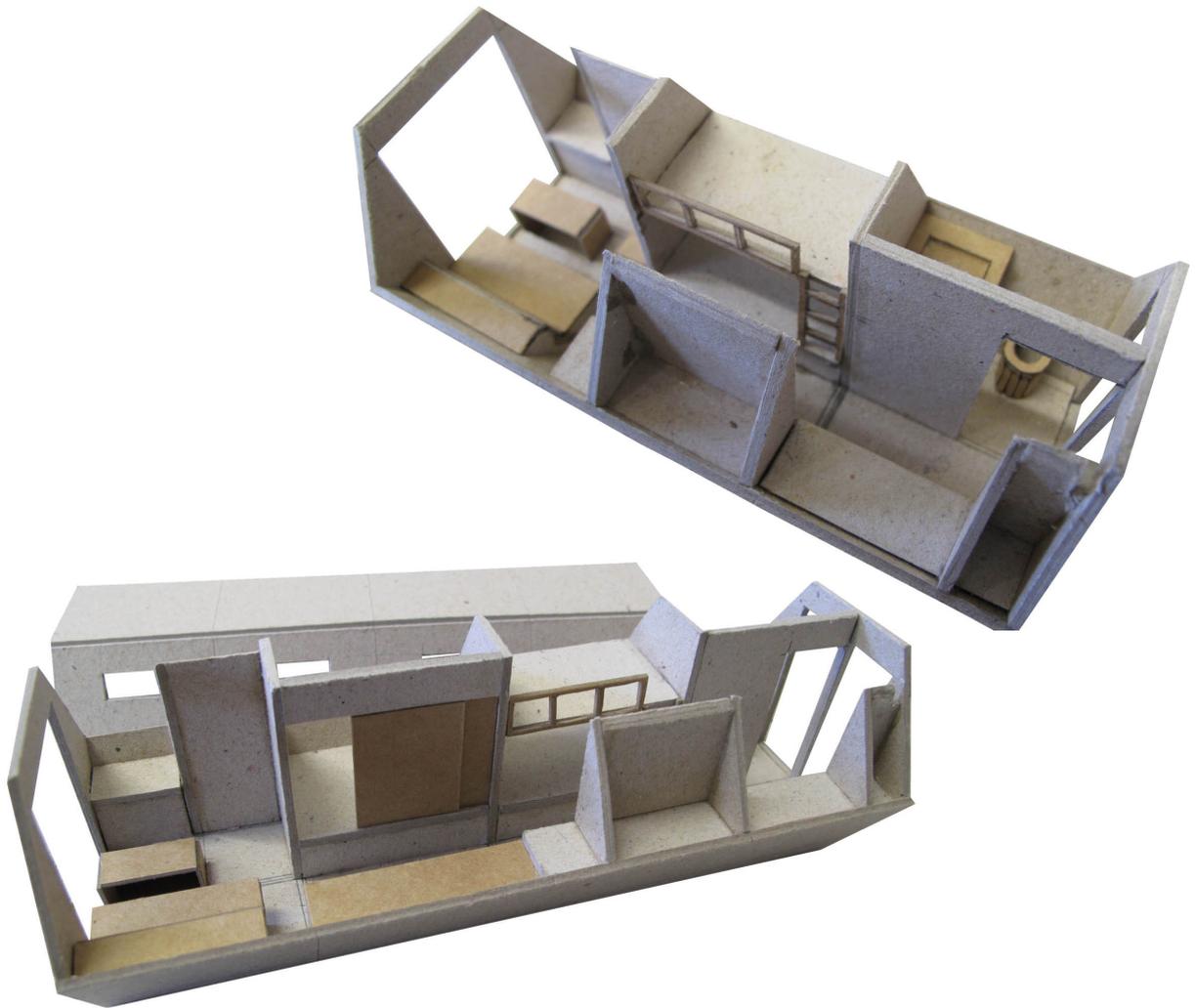


GROUND

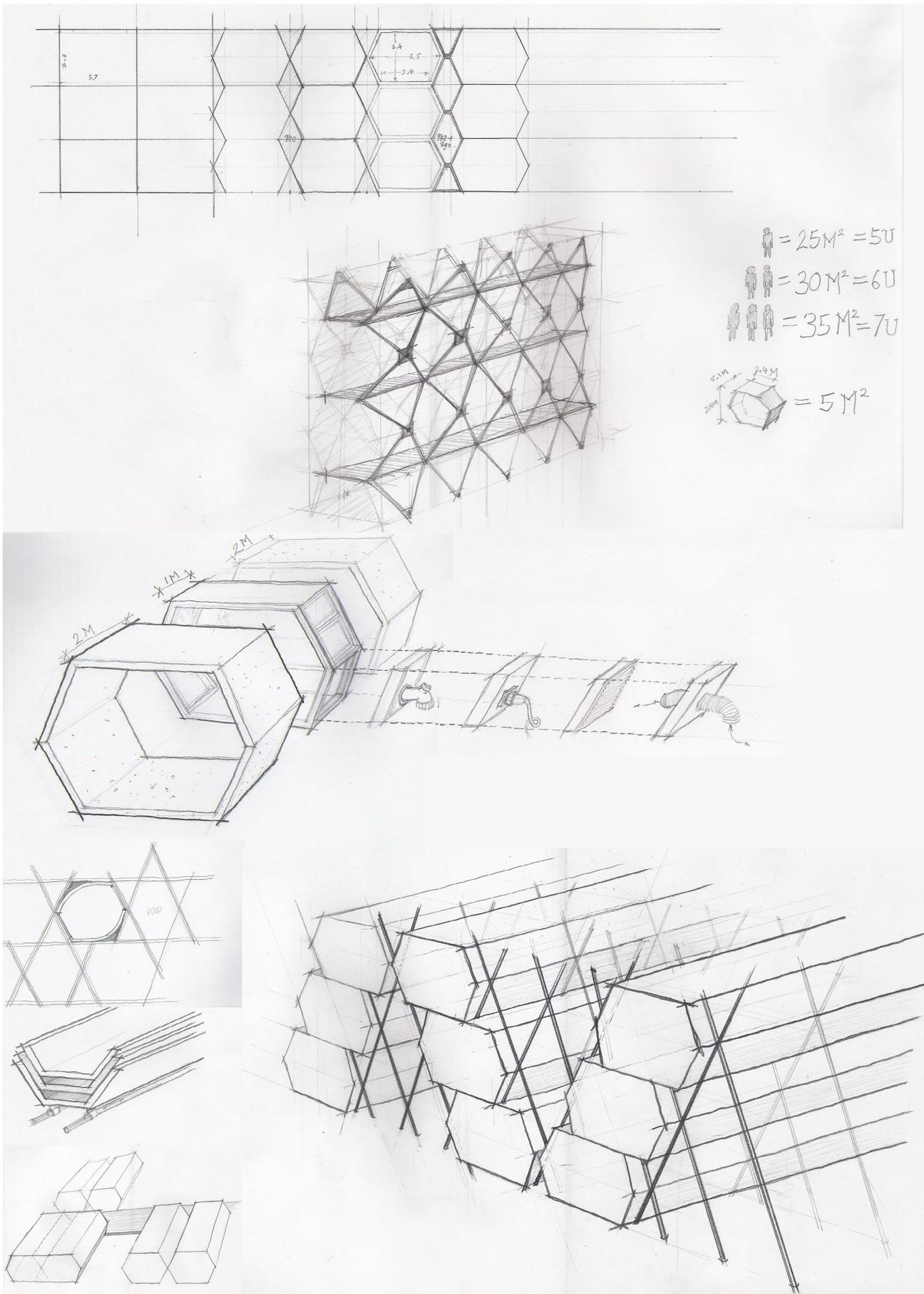


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