Prefabricated Construction Systems for Building and Civil works adopted in Hong Kong

Presented by

Raymond W M Wong

Division of Building Science & Technology

City University of Hong Kong

The presentation is based on a paper prepared by Raymond Wong for the

World Congress on Housing Process & Product,

Organized by the International Association for Housing Science and hosted by the Concordia University,

Montreal, Canada, June 2003

Development and Application of Prefabricated Technology in Building Construction in HK

1. Had been used once in early 1970s in a pilot project to construct a series of 17-storey public houses
2. Used in a broader scale in the mid/late 1980s in the construction of public houses where all the façades of the flats were constructed in precast in a after-fixed manner
3. Improvement to public houses by introducing in-situ joined façade and broader use of other precast elements in early/mid 1990s.
4. A few private developments pioneered in the use of prefabricated system in the construction of buildings of various nature since early 1990s

Development and Application (continue)

5. Packaged projects introduced from late 1990 onward by the Hong Kong government for the construction of a series of schools using semi-prefabricated method
6. A series of government quarter buildings using similar construction techniques were introduced in 2000
7. A few special buildings such as bus depot or train station podium employed large amount of prefabricated elements of which some were primary structural members (1997 onward)
8. Popular use of prefabricated external wall from 2002 onward in residential buildings due to the introduction of a new guideline encouraging the use of precast façades as a form of green elements in construction (exemption of Gross Floor Area)

Generations of Public Houses (Harmony Block) constructed using semi-prefabricated concept

First generation of Harmony Block using after-fix façade

Later version of Harmony Block using inisitu façade cast at the same time with structural walls

Precasting yard was set up to produce precast elements for public housing projects in early to mid 1990

After-fix façade system required the formation of small amount of in-situ joint and grouting that easily caused leaking problem

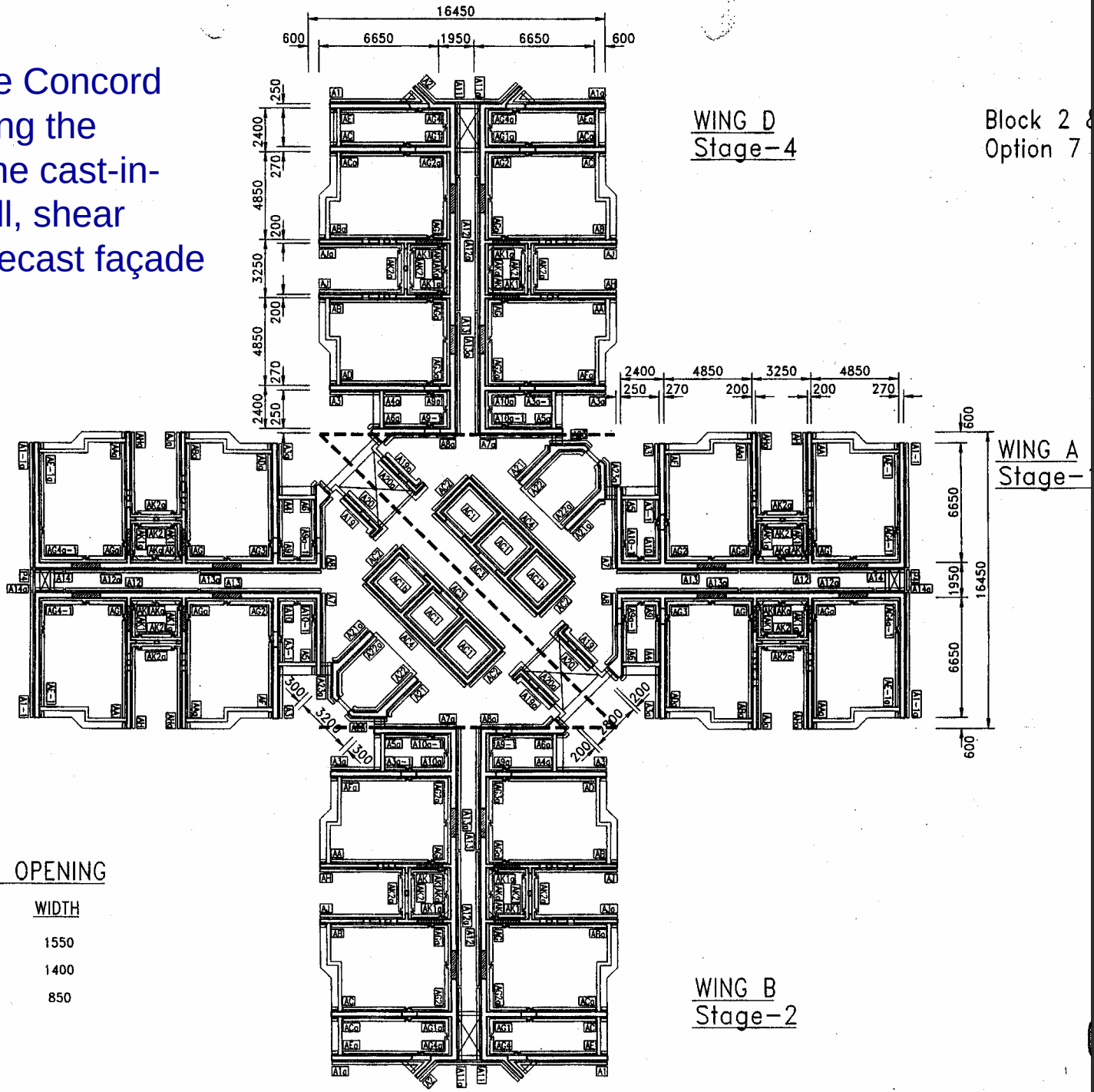
Detail of façade installation using in-situ jointing arrangement in the later version of Harmony Block Construction

Forming the floor slab in the Harmony Block construction using semi-slab (right) and aluminium formwork (above)

Introduction of mechanical formwork systems incorporating the standard precast elements in the construction of latest version of public houses in the late 1990

Public houses using Concord design with special emphasis on the use of mechanicalised construction system

Layout of the Concord Block showing the position of the cast-in-situ core wall, shear walls and precast façade



DIMENSION OF DOOR OPENING

	HEIGHT	WIDTH
▨	2175	1550
▩	2300	1400
▭	2150	850

Other pioneered projects in the early 1990 constructed using semi-prefabricated concept

The construction of the Headquarter and Members Facilities Complex for the Hong Kong Jockey Club

Forming the floor slab using precast secondary beams and semi-slab for the main building (above) and members' complex (right)

Detail of the floor system with the cast in-situ main beams and the place-in precast secondary beams

Introduction of prefabricated concept to construct government quarters in 2000

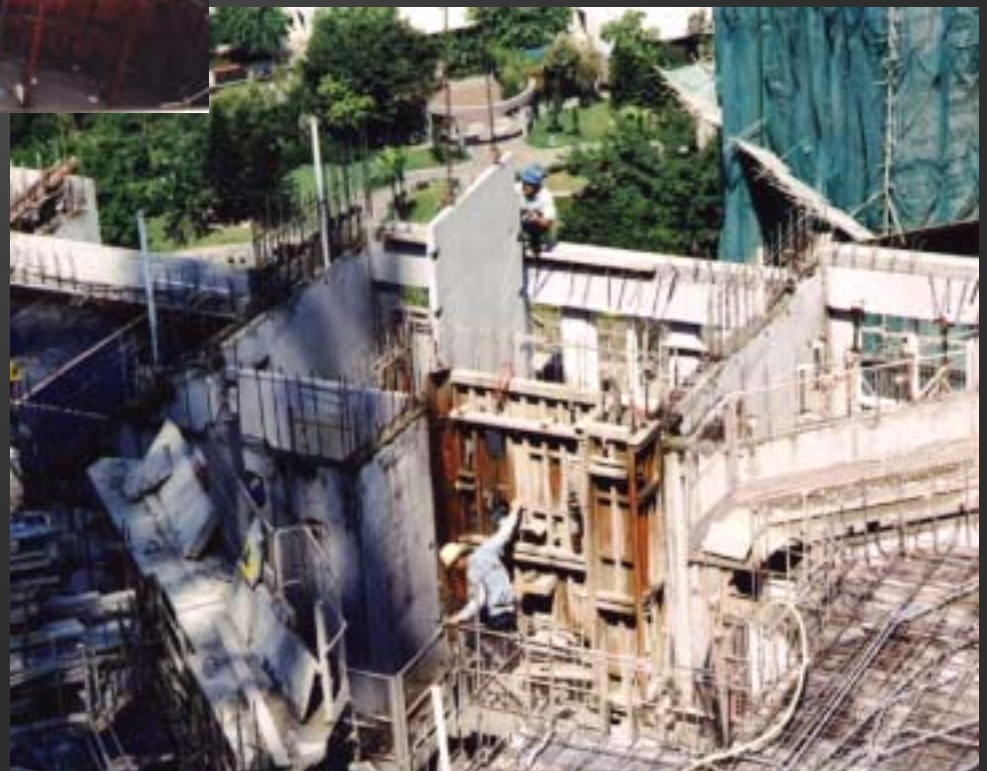
Government quarters
in West Kowloon

Layout of the quarter building showing typcial phasing arrangement of work

Features in the construction – extensive use of precast façade and lintel beams, precast cast-in-situ internal partitions are also introduced

Detail of the façade and
the lintel beam installation

Installation of the cast-in-situ precast internal partition



Construction of special buildings using high proportion of precast since 1998

Kowloon Canton Railway Station podium/deck

Construction of the Kowloon Canton Rail podium deck – cargo handling bay on the ground level and on top for a large-scale residential development afterward

Forming of the cast-in-situ main beams

Jointing detail of the main beam and precast secondary beams

Semi-slab with RC topping to form the composite podium deck

Kowloon Motor Bus Maintenance Depot

- 3-level depot building with columns, main and secondary beams all in precast

Erecting of the building frame
using precast columns and beams

Connecting the precast column to the foundation cap with a base plate

Placing the secondary beams onto the main beam

Connecting beams to columns by stitching, a means to provide an in-situ joints with rigid RC links

Detail of the beam/column and beam/beam joints

Recent Residential/Commercial Developments using prefabricated concept to construct

Residential development
at Cyber Port

Façade and general installation details

Features in the construction – large amount of external walls are constructed in precast façade untis, with major structural links tie back to the inner shear walls and floor slab

Incorporation of other sophisticated formwork in construction – steel gang form for walls and table form for floor

Residential Development at Taikoo Valley

Construction features – the use of large amount of precast units both of structural or architectural nature. This includes the balcony, façade units, loss-form for external walls and some shading fins.

Detail of the precast balcony unit

Detail of the loss-form

Residential development
at Ma Tau Wai

Overview of the precast installation arrangement

Façade installation detail
as seen on the floor deck

Cambridge House – a 42-storey Office Building at Quarry Bay

Features in construction – precast beam trough and precast sub-slab with RC topping forming the floor system

Placing of the precast beam trough to form the floor layout

Recent Achievements of Hong Kong's Prefabricated Technology

- Previous defects such as leakage problems have been improved
- Application diversified to other forms of construction
- Capable to apply to rather complicate-shaped buildings
- Incorporation of other advanced technology in the construction (such as use with mechanical form/ tensioned elements)
- Generally mastering of skill and growing popular

Future Trend in the application of Prefabricated Technology in Hong Kong

1. To increase the use of prefabrication for more structural elements such as for beam, column or load bearing wall
2. Use more modulated elements or plug-in units
3. Use more for architectural or decorative elements
4. Incorporation of other composite elements in the design such as using at the same time with structural steel
5. Apply prefabrication more to medium-rise buildings with more standardized structural items
6. Improve the supply chain management to make production more efficient and economical

Practical Constraints

1. Tighter coordination to allow for structural design, construction planning, procurement & approval procedure
2. Required a critical amount of precast items before work can be economically used
3. Huge work space for handling precast elements especially in congested urban environment in Hong Kong
4. Congested site environment makes access and delivery of heavy precast units to the work spot becomes difficult
5. Quality assurance become critical especially where large amount of precast components are used as structural nature

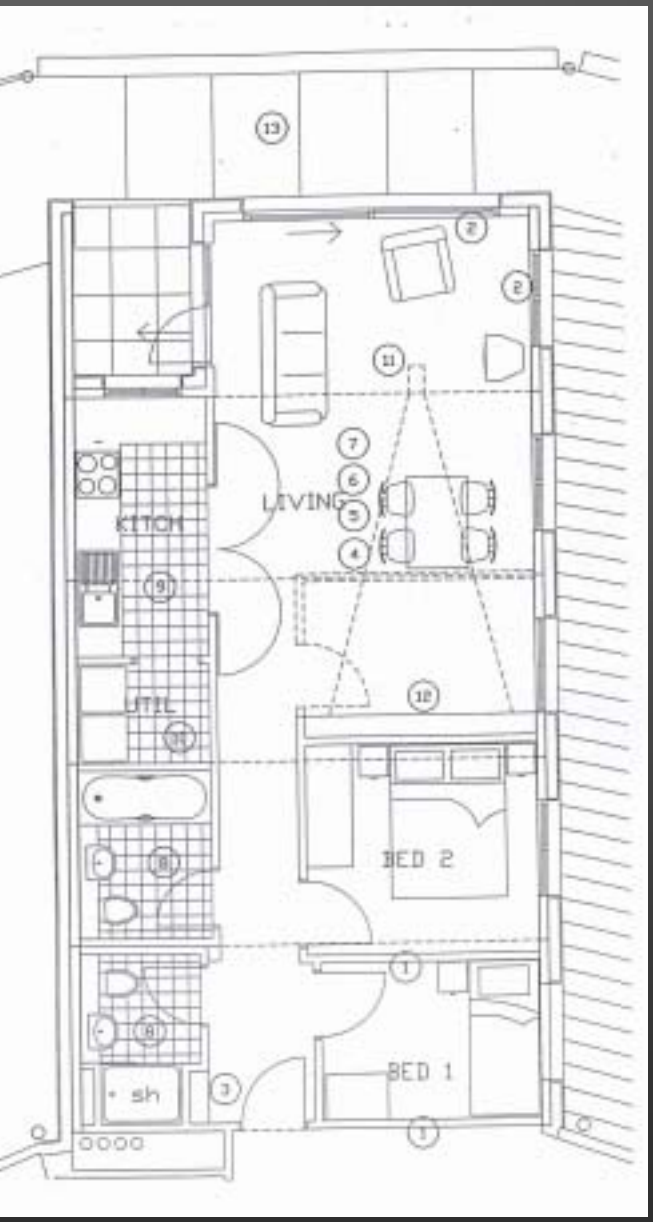
Examples of very congested construction environment where prefabrication approach is adopted

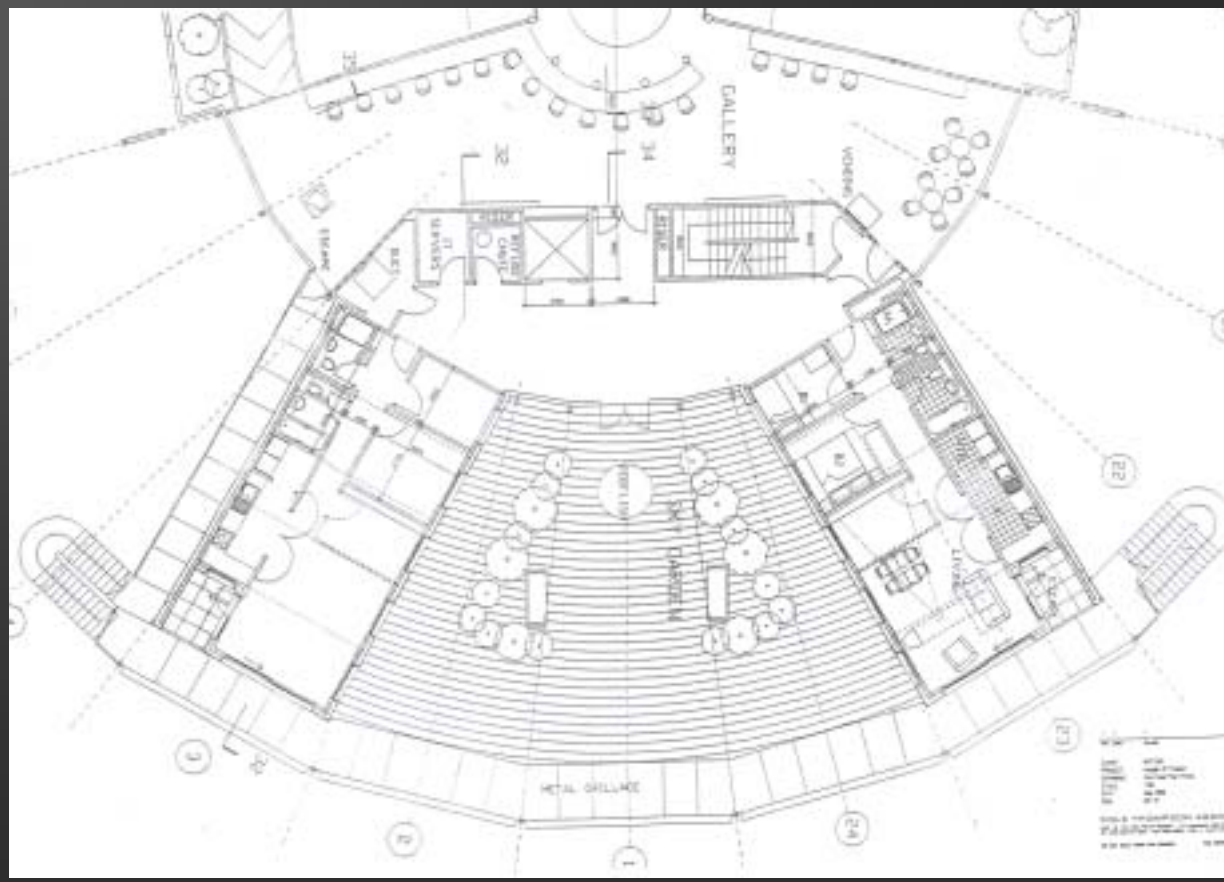
Example of Innovative Project (Local)

The Integer

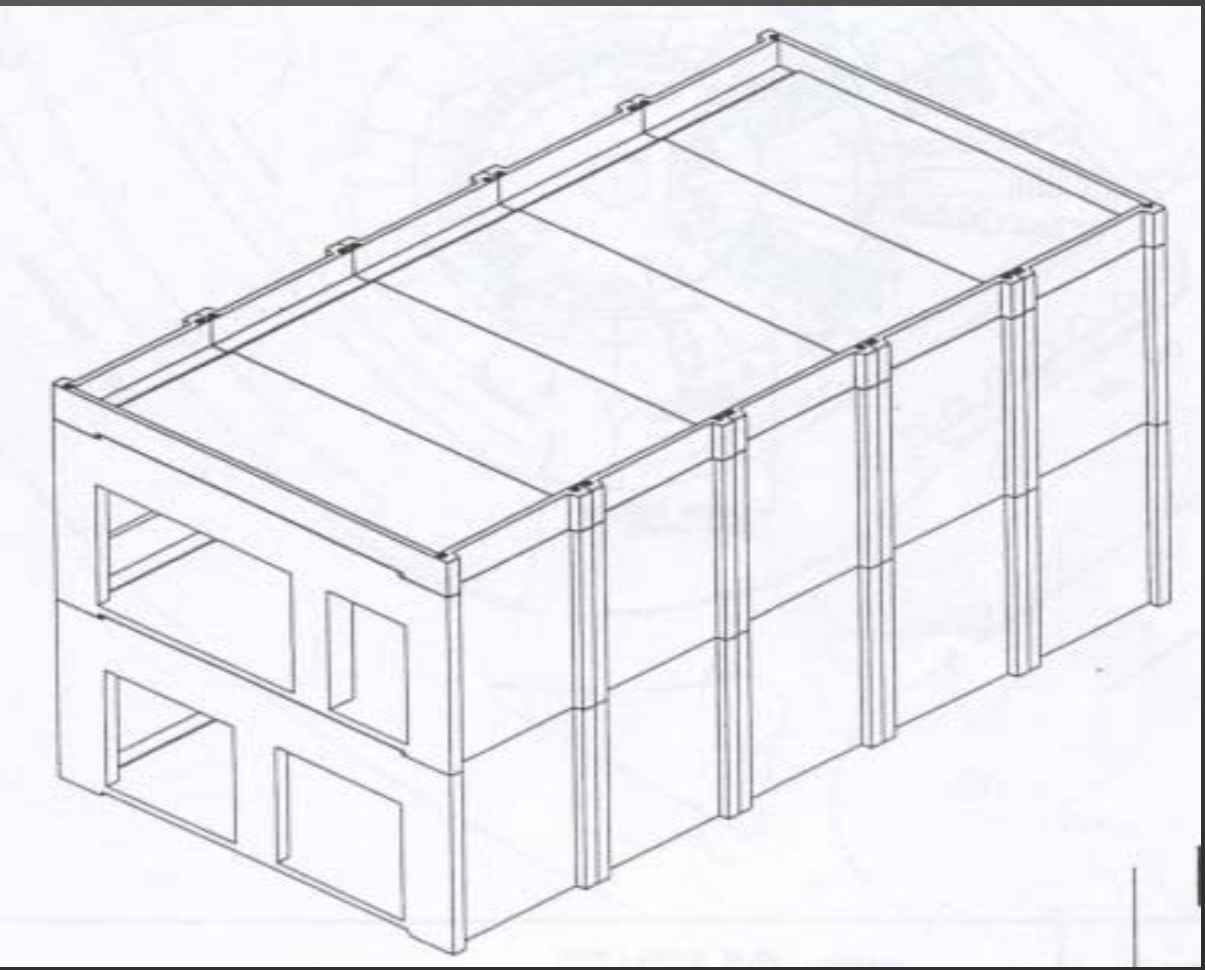
The Integer House
at Admiralty

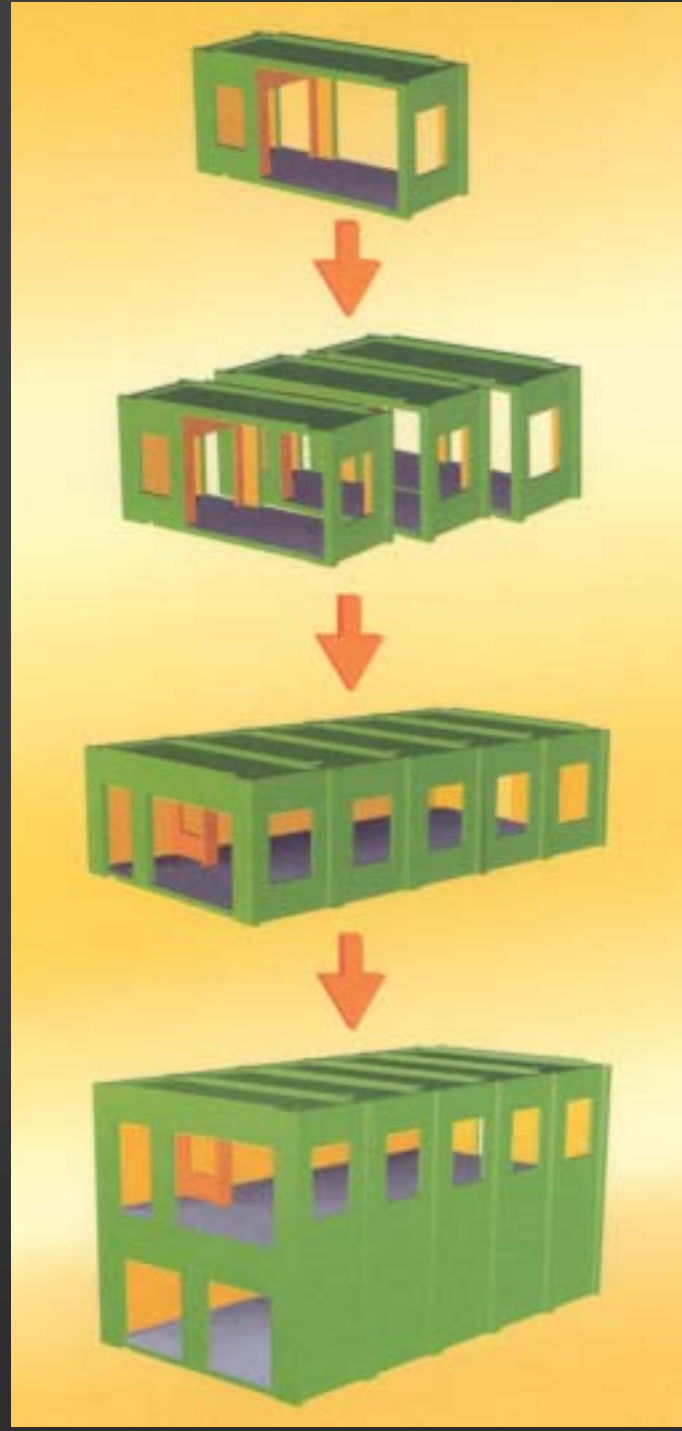
Floor plan of the experimental house



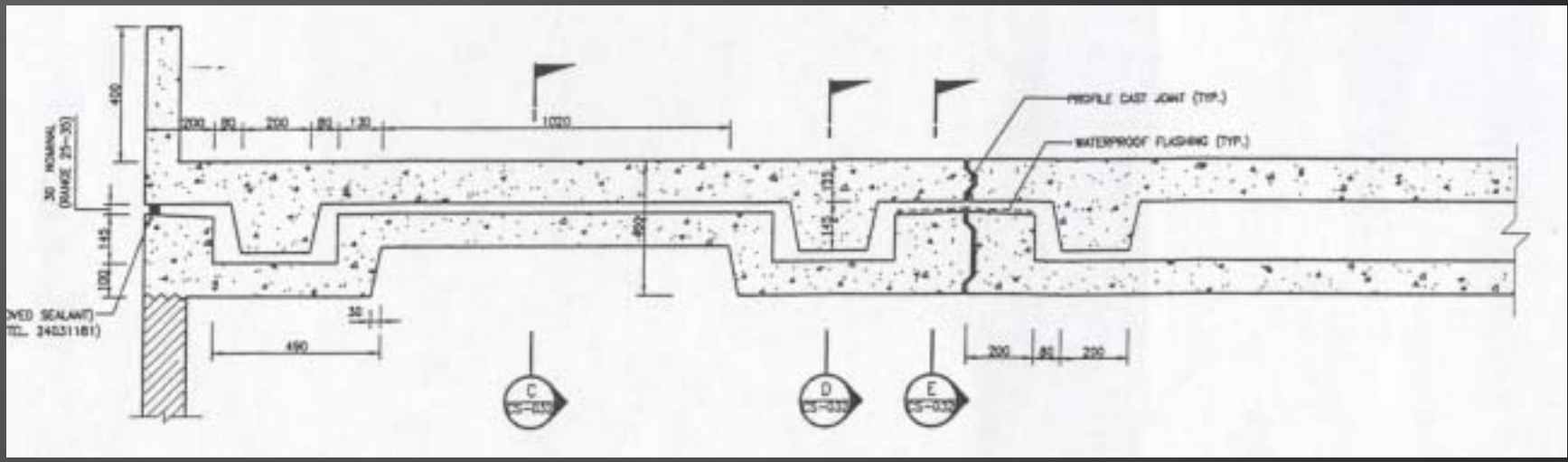


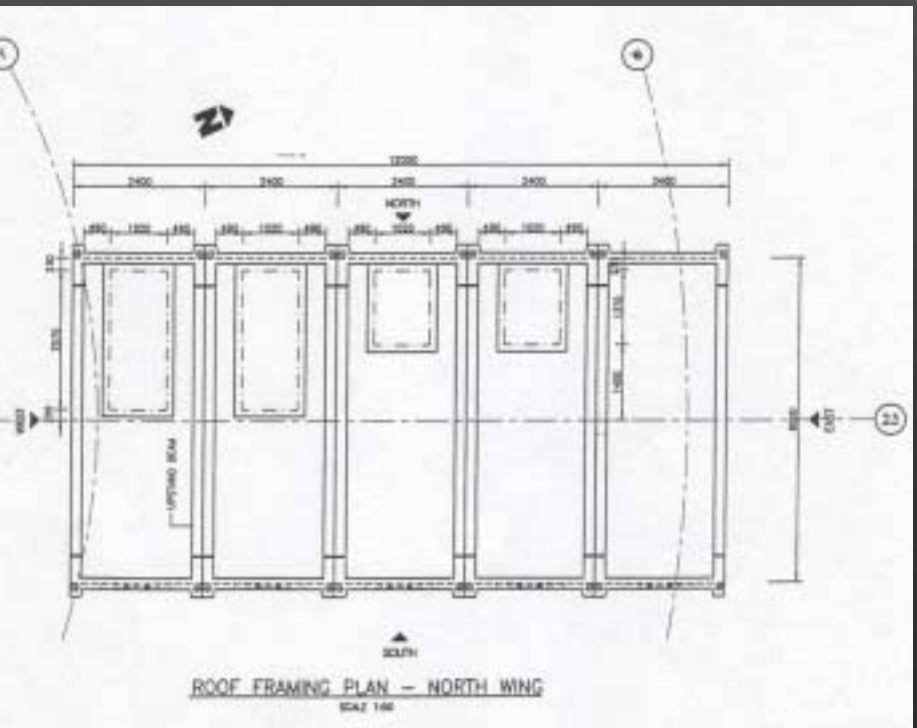
The working concept

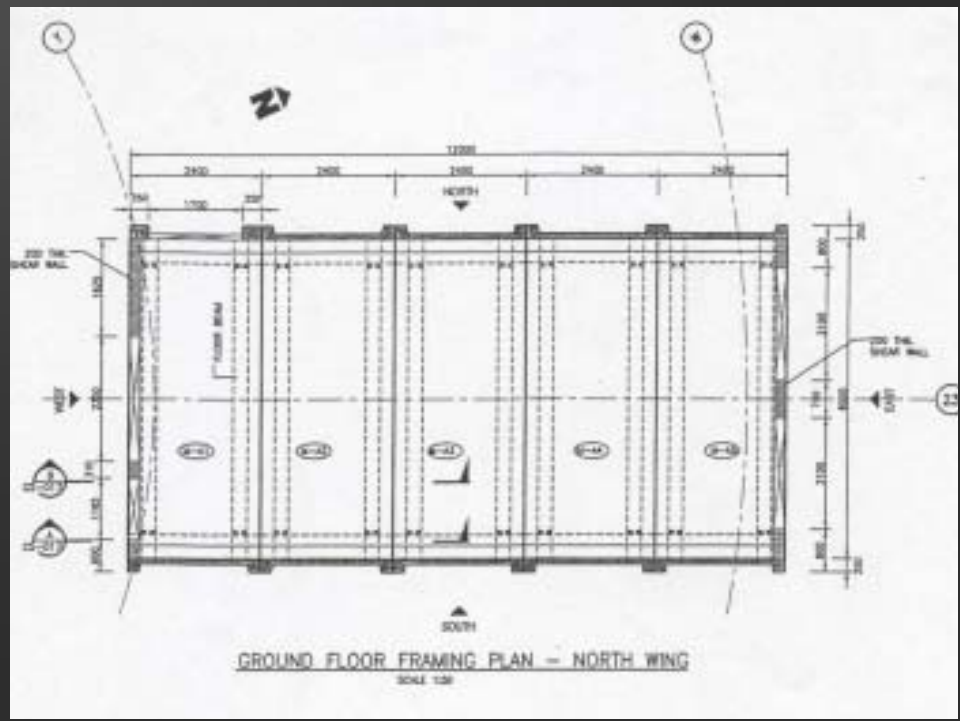




Typical connection details

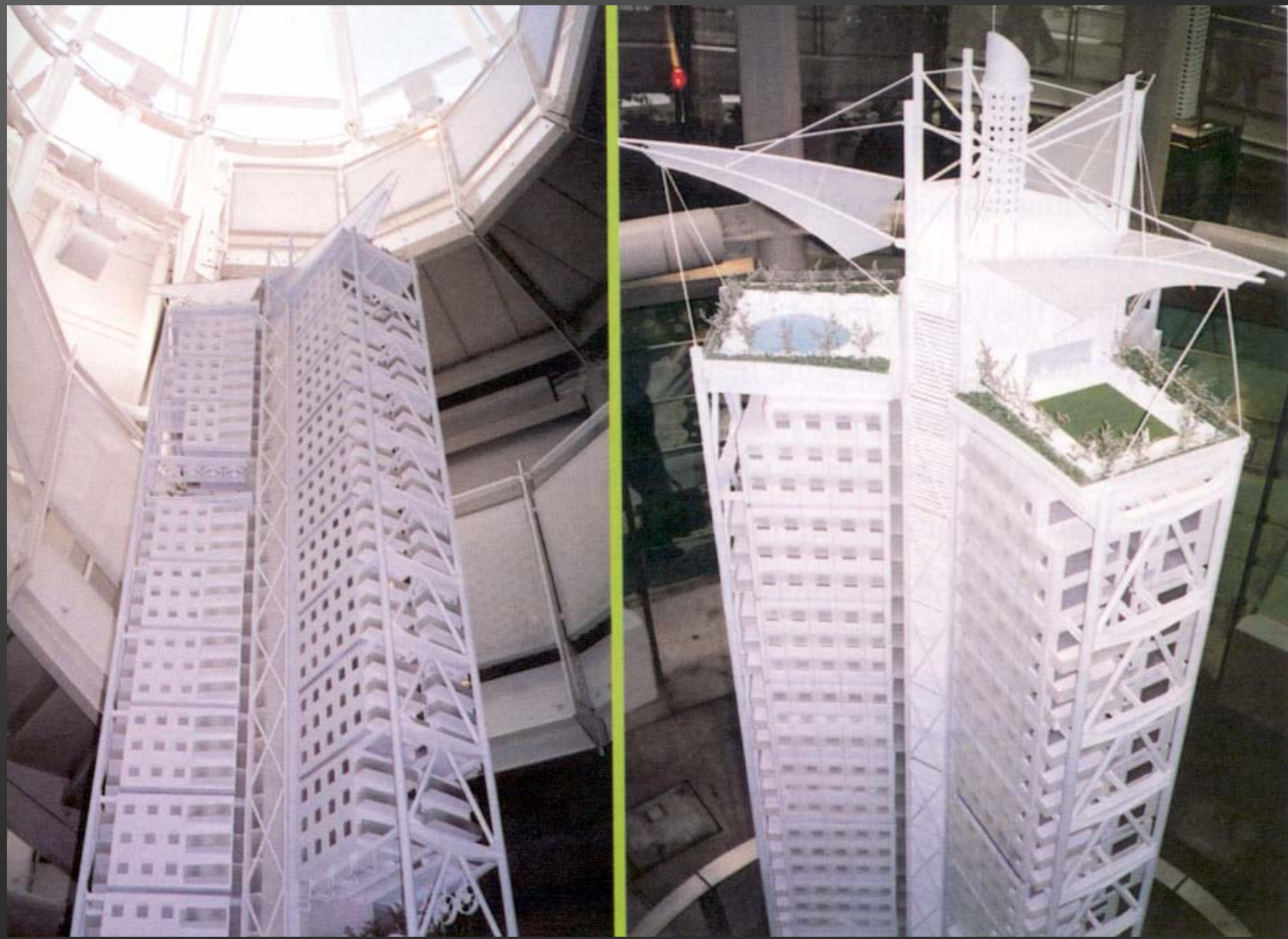






Assembly of the 3-D modules

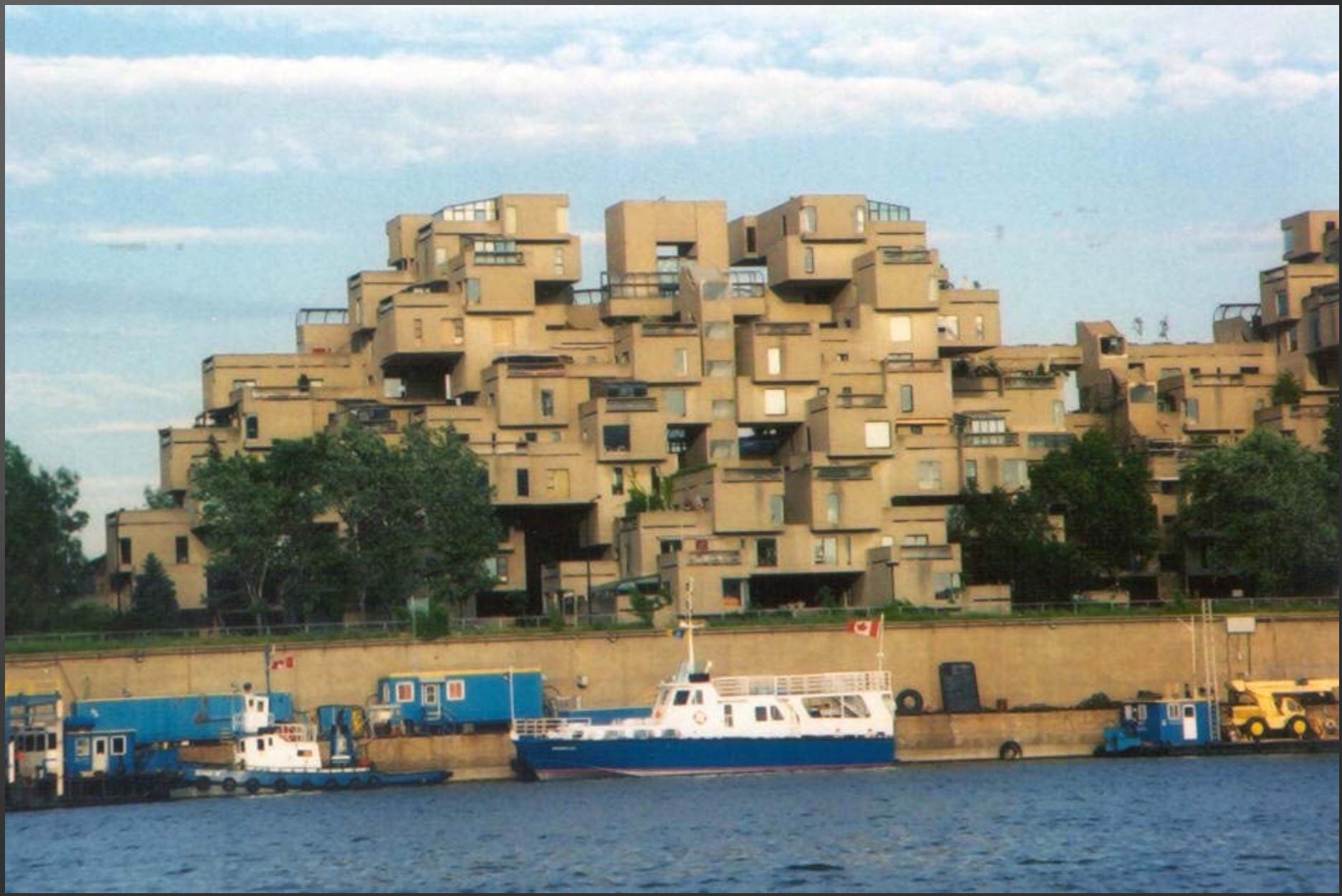
Possible future development for high-rise structures using similar concept



Example of Innovative Project (overseas)

The Habitat 67 in Montreal, Canada

Habitat 67 as seen along the bank of St Lawrence River

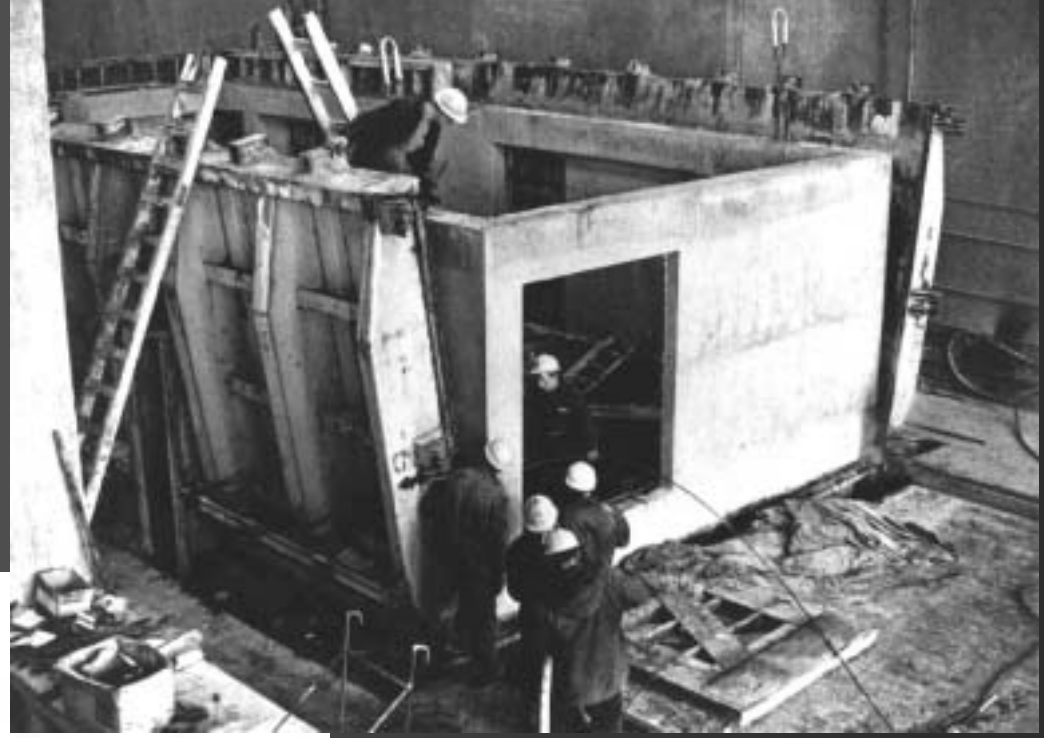


Habitat 67 as seen along the bank of St Lawrence River

Close up look of the modulated dwelling units

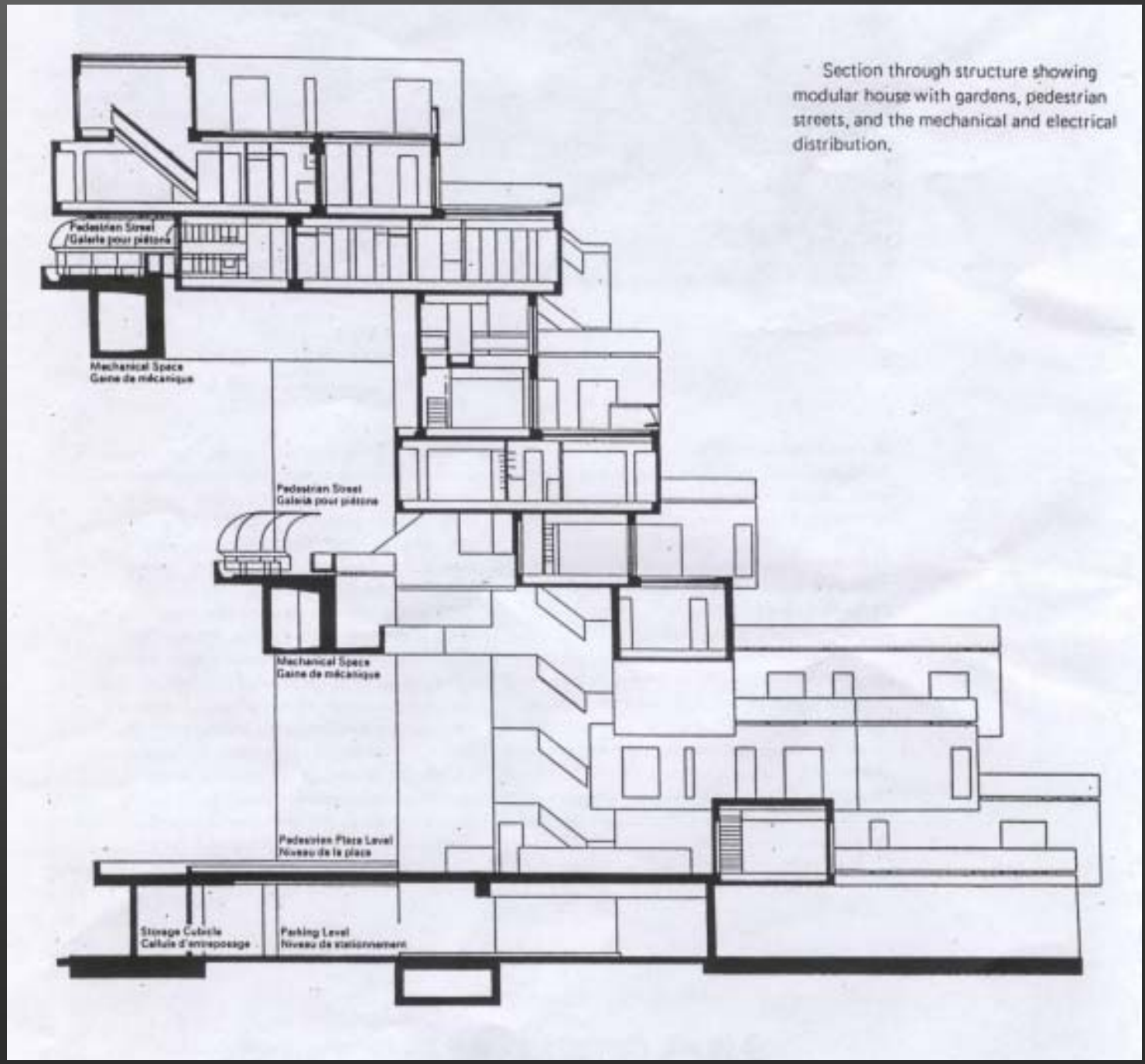
Close up look of the modulated dwelling units and the linking structure in the form of a access corridor

View as seen on
the deck level

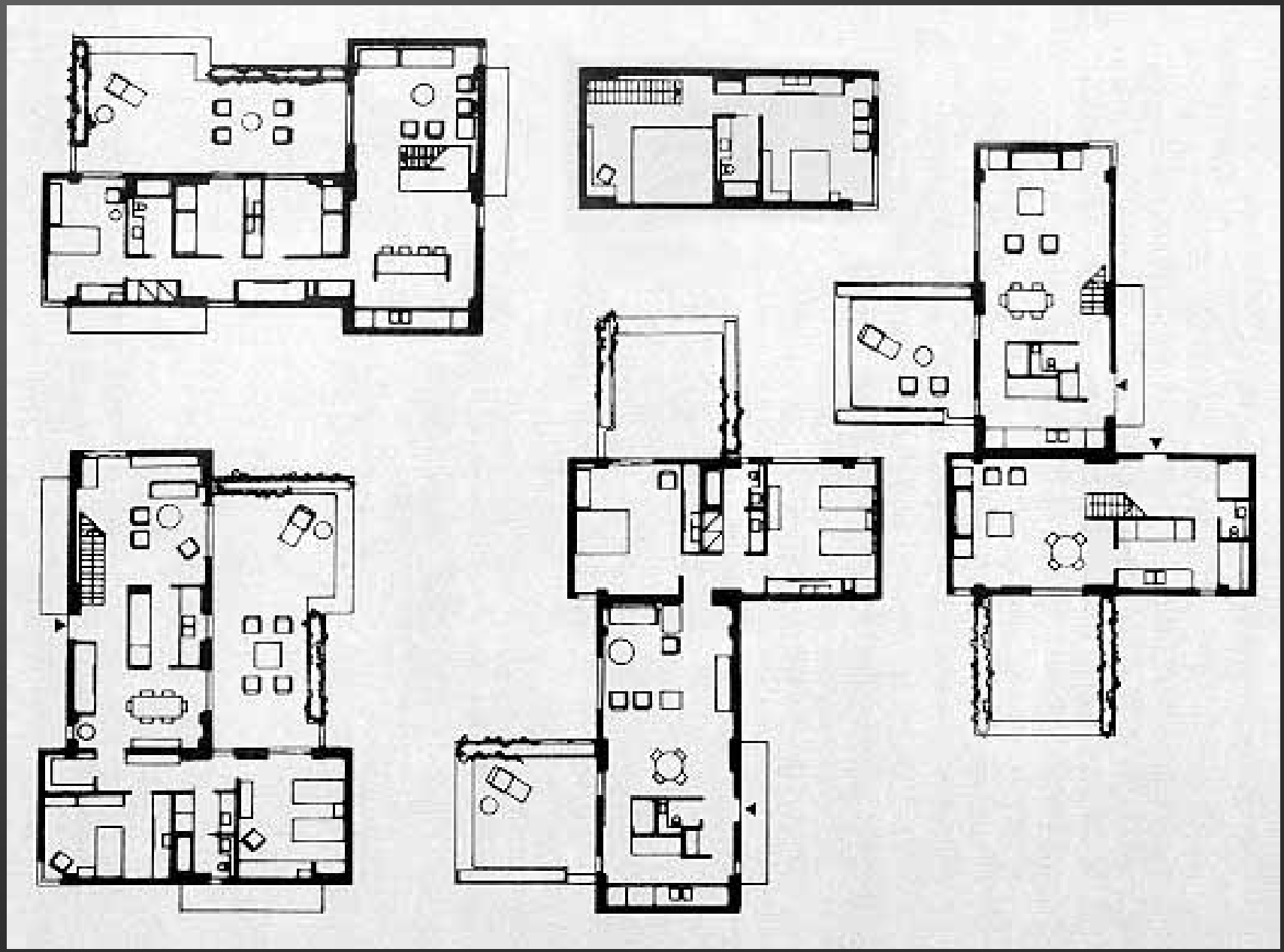


Forming and Installation of the modulated units

Installation of the modulated units and the associated structure

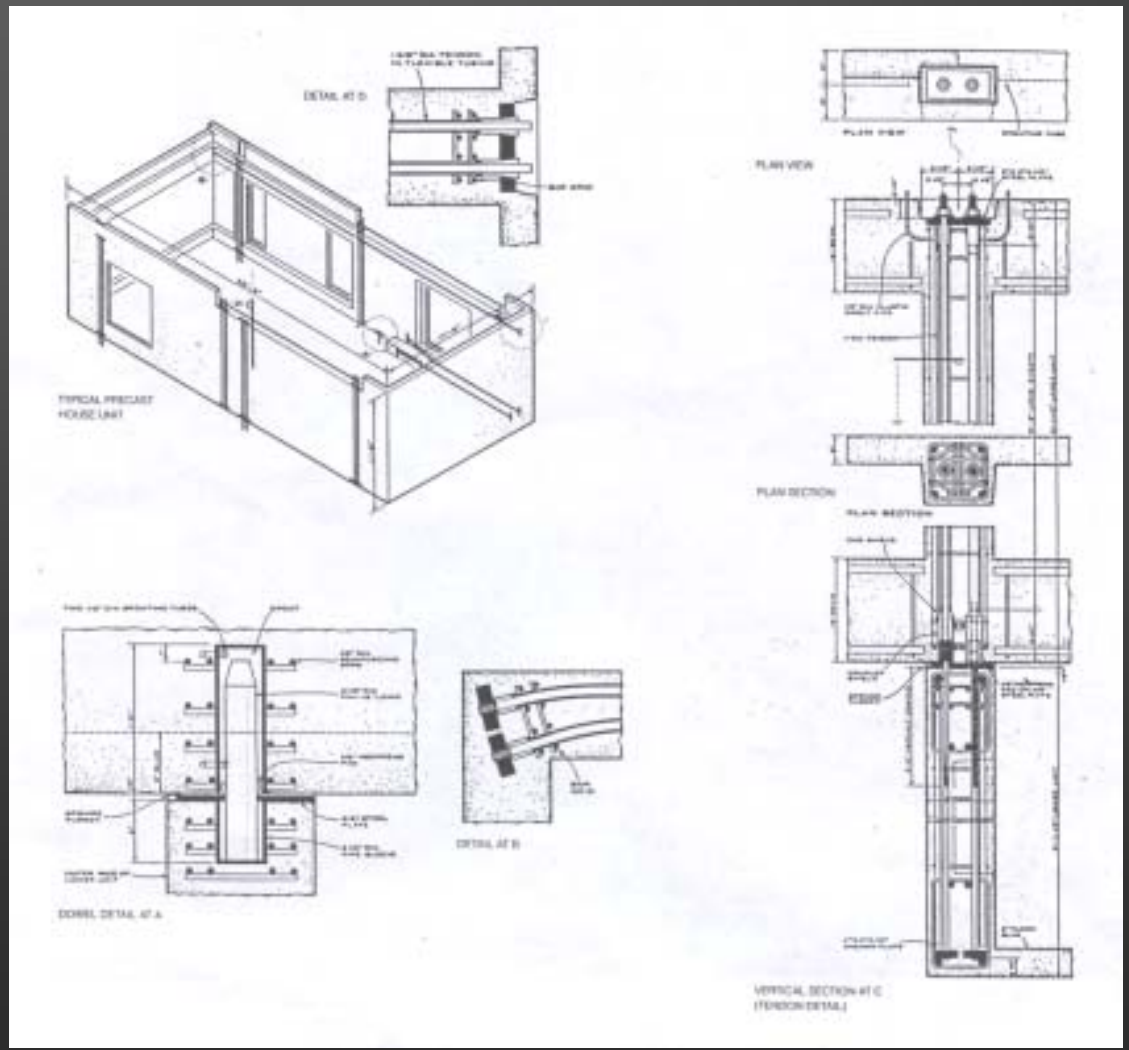


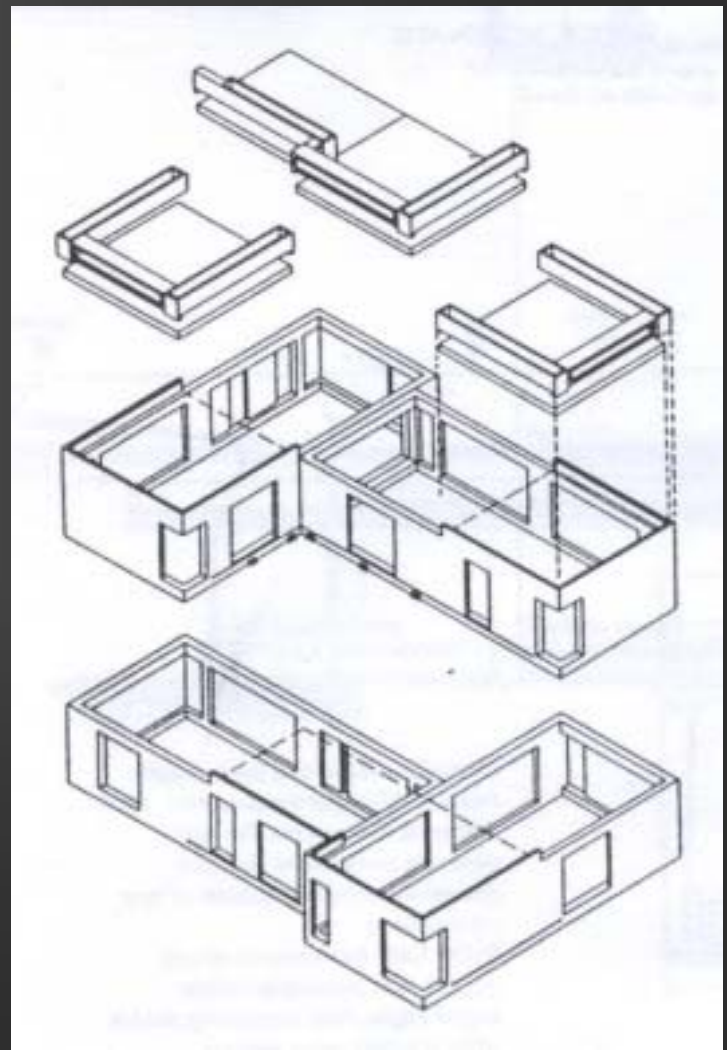
Building Section



Floor plan

Connecting the modules





Prefabricated Construction

Application in Civil Works

Examples of application of prefabricated techniques in civil construction works

1. Used in highway projects such as cantilevered deck of elevated bridge, parapets of expressway and road curb
2. Precast girder units or beams for elevated roadway (viaduct)
3. Precast beams or decks for elevated pedestrian footbridges
4. Tunnel lining especially for tunnel formed by tunnel boring machine
5. Decks for long span bridges

Examples of application (continue)

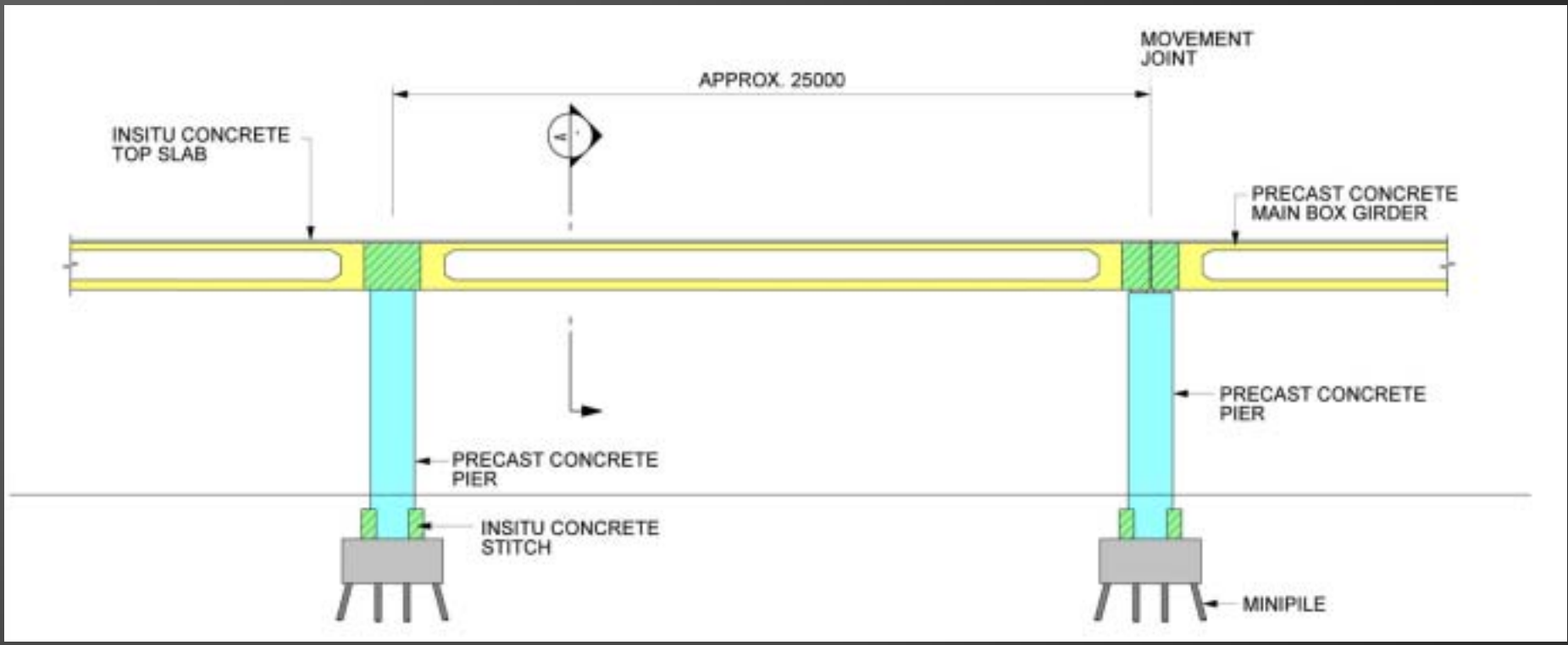
6. Marine work such as seawall and deck of terminal berth
7. Soil retaining element such as for earth-balanced type retaining structure
8. Platform for railway station
9. Parapets and noise barrier panels
10. Overhanging ducts or services channels for underground facilities
11. Nullah section for storm water discharge

Elevated pedestrian footbridge in Mong Kok

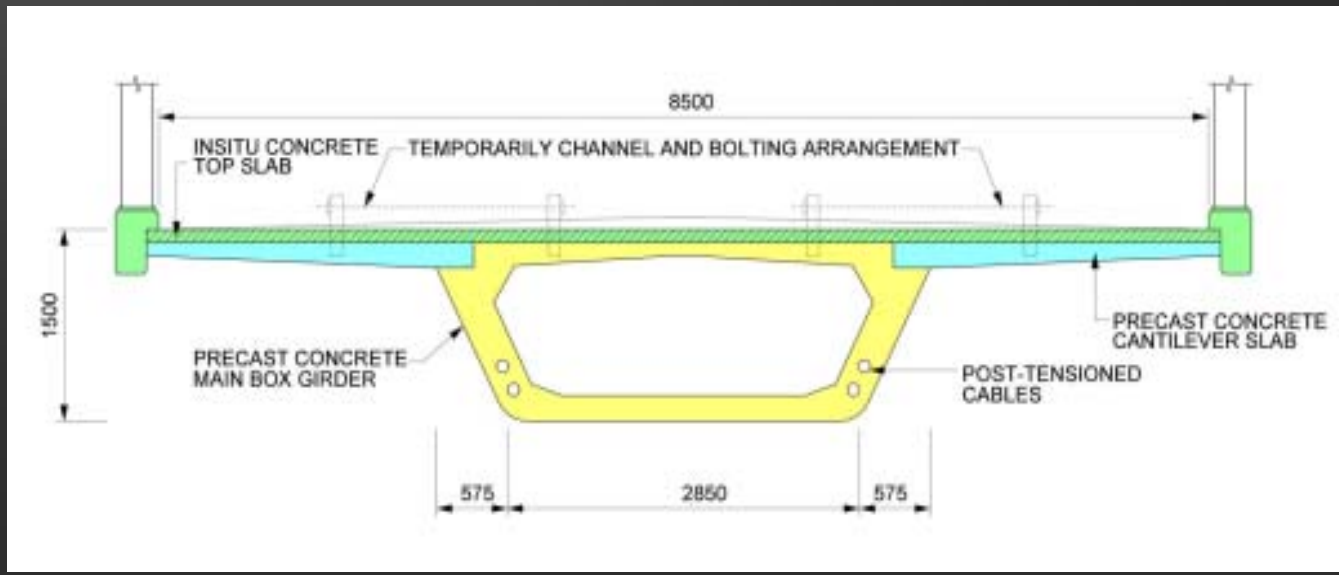
Piers formed using
precast column

Precast girder erected on top of the piers to form the main span of the footbridge

Extending precast plank to
form the deck of the footbridge



Structural arrangement of the footbridge



Precast V-shape beam
for the Route 3
elevated expressway
at Kwai Chung

Precast V-shape beam
being lifted to pier head
by launching gantry

Precast box-girder for the Rambler Strait Bridge of Route 3

Forming the elevated bridge of the West Kowloon Expressway

West Kowloon Expressway – installing the precast box girder using balanced cantilever method with the help of track mounted gantry crane

Forming the elevated track of the West Rail using the slung launching girder

Forming the elevated track of the West Rail using the longitudinal steel support beam

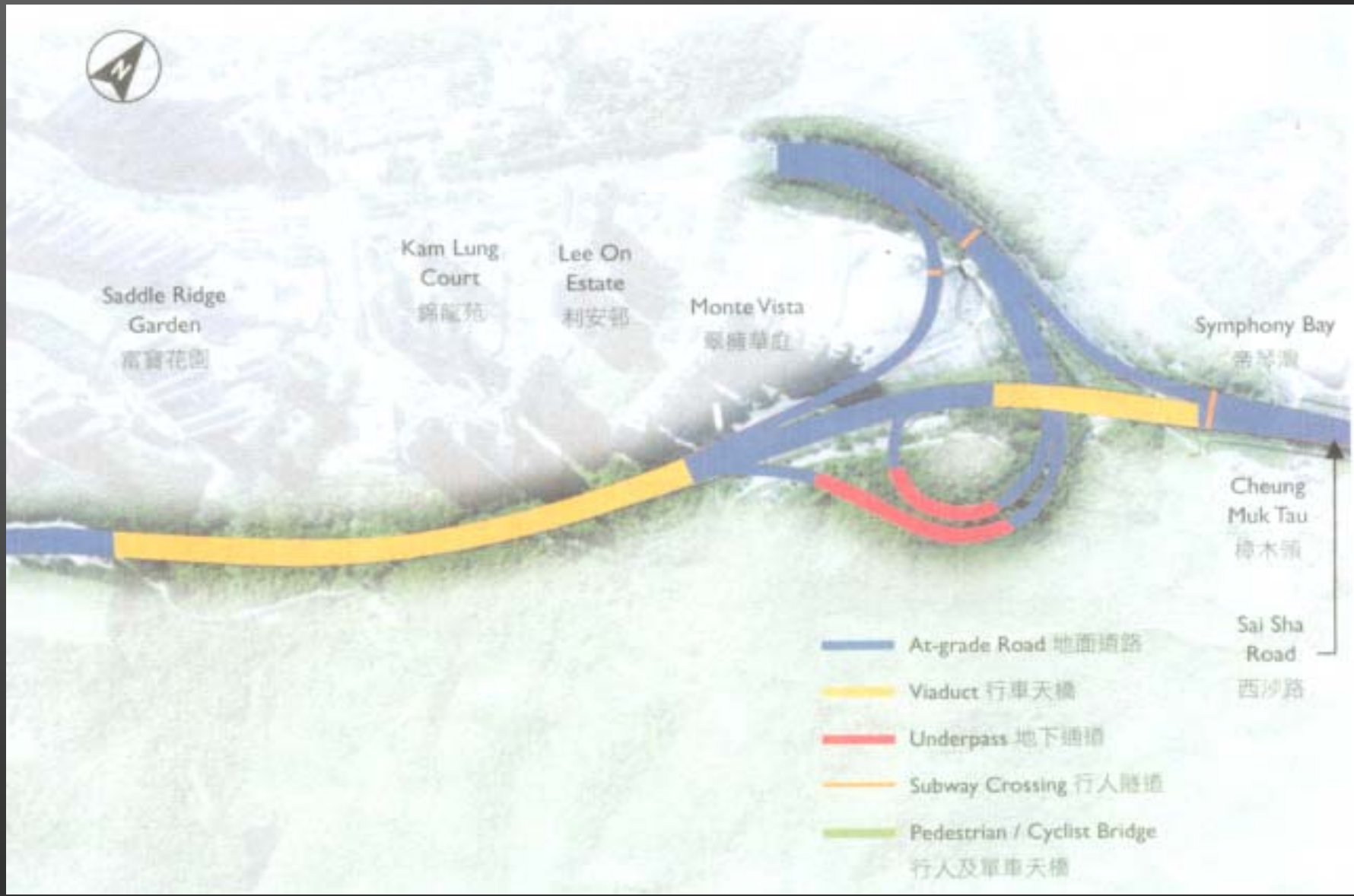
Forming the elevated track of the KCR Ma On Shan Line by precast girder and lifted to deck level for erection using mobile crane

Placing the precast girder in position

Project example – Road T7 in Ma On Shan (TTD project)

Technical Features

1. Total length of viaduct – 2200m (approx.)
2. Span length – Average 40m
3. Total nos. of segment used – 790 nos.
4. No. of segment per span – average 14 nos.
5. Weight of segment – ranging from 50 to 98 tons
6. Weight of the launching machine – 310 tons
7. Max. weight of machine with segments – 1300 tons
8. Length of launching machine – 85m
9. Casting of the box-girder segment – match-cast



Construction of highway bridge using precast box-girder (viaduct) – Road T7 in Ma On Shan

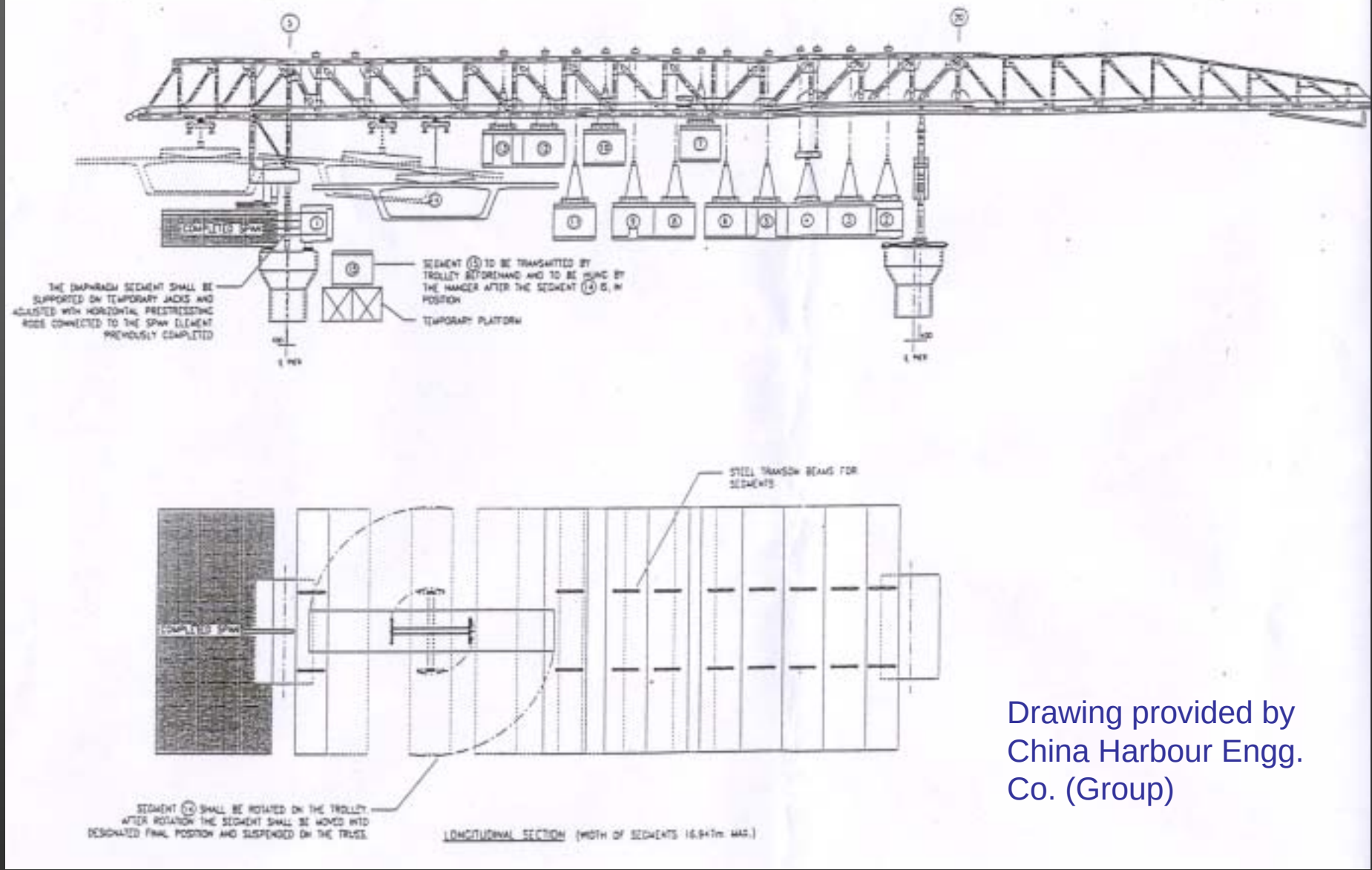
Early stage of the project – formation and forming the piers for the viaduct

Overall layout of the precasting yard

Forming the box-girder units

Formwork to form the inner void of the box-girder units

Overview of the launching machine



Drawing provided by China Harbour Engg. Co. (Group)

Launching sequence of the box-girder units using launching machine

Installation of the box-girders

Installation of the box-girders

Other example of application in civil engineering works

Precast parapet unit for the highway and railway road/track way

Precast floating slab for
the laying of railway track

Tunnel lining formed
by precast segments

Detail of the lining as
seen inside the tunnel tube

Forming the station platform using precast curb and plank (KCR Tsim Sha Tsui Station)

Forming the cable hood

Delivery of the precast units

Forming the deck of the Ting Kau Bridge using precast concrete plank

Forming the deck of the berth for the Container Terminal No. 9

Precast concrete plank
as cover to podium deck

Precast vertical panel forming an earth-reinforced type retaining structure

Forming storm water discharge culvert – Tseung Kwan O Reclamation

Prepare for the foundation
to support the culvert

Delivery and storage along
the temporary seawall

Precast units to form the 4m high 5-cell culvert system in Tseung Kwan O

Positioning the Precast units onto the culvert alignment

Precast culvert in the form of semi-submerged tube – Tsuen Wan West Reclamation as advanced work for the West Rail Tsuen Wan Station

Sinking of the precast culvert section

Positioning of the culvert section onto to formed bed

Connecting the culvert from the precast section to the in-situ section

Precast box as footing to bridge tower – Tsing Ma Bridge tower on Ma Wan side

Precast box as pump house for water cooling system in the Central Reclamation

End of Presentation
and
Thank you

If you require more information about the Author's recent work on various technology topics, you can enter his homepage at

http://personal.cityu.edu.hk/~bswmwong/