Construction and Performance of Curtain Wall Systems for Super Highrise Buildings – the Hong Kong’s Experience

Prepared by

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Development of Curtain Wall Systems in Hong Kong

1st Generation – Early to late 1970’s

features: mainly non-proprietary products design by local window manufacturers.

common systems: stick-type, spandrel and cover, unit-in-frame types

material: aluminium sections, fabricated locally and erected in-situ using manual means
Development of Curtain Wall Systems in Hong Kong (Cont.)

2nd Generation – Early 1980’s to early 90’s

features: mainly proprietary products usually in standard design out from the manufacturer’s inventory

common systems: stick-type, spandrel and cover, unit-in-frame and sometimes unitized types

material: sections in aluminium or its alloys, fabricated overseas and delivered to site for installation.
Development of Curtain Wall Systems in Hong Kong (Cont.)

3rd Generation – mid 1990’s onward

features: mainly proprietary or expert products usually tailor-designed and made for highly specific purposes

common systems: majority are in unitized types

material: sections in aluminium alloys, some in stainless steel, large areas of glass was also used, large amount of accessories and fixing components are involved, components fabricated overseas (incl. China) and delivered to site for installation.
Use of Curtain Wall Systems in Hong Kong’s buildings (Cont.)

1) Office buildings
2) hotels
3) Shopping centers
4) Public/Functional buildings
5) Residential buildings
6) Other types
The city profile of Hong Kong as viewed from the Kowloon Peninsula. Generations of tall buildings sprung up from the harbour side since the 1970’s can be seen.
Aerial views of the downtown area of Central District
Close up seeing the building façades of some high-rise buildings in downtown areas
Buildings using Curtain wall of the first generation - The office zone of East Tsim Sha Tsui developed in the late 1970’s
Common types of curtain wall systems for high-rise buildings

1) Stick system
2) Unit system
3) Unit and mullion system
4) Column-cover and spandrel system
5) Various types of glass wall system
Typical stick system wall – the Gateway at Tsim Sha Tsui
Typical unitized system wall – the Cheung Kong Center
Glass wall and skylight for the Festival Walk Shopping Mall
Glass wall for the Terminal Building at Hong Kong Chek Lap Kok International Airport
Glass wall used for the Hong Kong Convention and Exhibition Center
The glass wall for the International Finance Center (Hong Kong Station)
Glass Hubs at podium roof of the International Finance Center
Curtain wall for the Cyberport Development
Functions and performance requirements of curtain wall for high-rise buildings

situations where buildings in Hong Kong are expected to face

• Very large building envelop (say, up to 50000 sq m)
• Typhoon situations (wind speed up to 60m/s)
• Thunderstorm situations
• Extreme temperature difference
• Exposure to salty or polluted atmosphere
• Long period of air-conditioning/cooling time
Functions and performance requirements of curtain wall for high-rise buildings

1) strength and stability – dead load and wind load
2) weather resistance – ability to keep out water & wind
3) thermal insulation and condensation – max 30W/sq m
4) sound insulation – 25dB or above
5) fire resistance – usually no specific requirement if enough separating distance from relevant boundary is provided
Testing of curtain wall

1) air infiltration
2) water penetration under static & dynamic pressure
3) structural adequacy under static & dynamic pressure
4) vertical and horizontal seismic movement
5) hinge and frame test
6) in-situ pull-out test
Installation process

1) transportation, storage and handling
2) anchorage and connection provision
3) installation arrangement
4) final fixing and inspection
Handling of the window units
Built-in anchor and hanging brackets
Cases for References
Shun Hing Plaza

- 68-storey office building constructed in composite form (core wall plus external steel frame)
Installing of the curtain wall
Close up of the mullion frame at the external faces of building
Close up of the walling frame with mullion and transom in position
Wall to cover the bracing members located in the building exterior
Fixing the mullion onto the floor structure
Detail of the fixing bracket
Wall framing components
Manulife Tower (Lee Garden Hotel Redevelopment) –
50-storey office building in composite construction
Overview of the building’s exterior
Curtain wall installation for the typical floors
Close up of the rebate on the sides of the building exterior
Close up seeing the walling arrangement of the sky garden
The hanger brackets and the secured units on the floor edges
Transporting the wall units into the building interiors
Placing the window unit into position
Close up of the standard units
To be continued in Part II . . .
The Center

- A 80-storey office building constructed in structural steel frame (mega-structure).
The configuration of the building frame
A separating line between the curtain wall and the building structure—work suspended pending to the approval of the fixing detail.
Gondola set up to facilitate the installation of the curtain wall units
Hanging, fixing and joining detail of the units
Pyramid feature at the building corners
The backing structure of the pyramid feature
Detail of the backing frame before placing of the glass panes
Forming the inverted pyramid feature at one of the building corners
Seeing the window from the pyramid’s interior
Wall cleansing machine and the sliding door on the penthouse
Rail track for the hanging-type sliding door to provide a flush exterior look for an opening for the wall cleansing machine
Stretching out of the wall cleansing machine from a hydraulic arm
Close up detail of the automatic cleansing robot that mounted onto concealed track provided on the window units
Cheung Kong Center

- A 62-storey office building in composite construction
Installing the curtain wall during the construction of the superstructure
Belt truss at building top

Curtain wall installation close to the building top
Belt-truss and Outrigger systems

Transfer Truss system
Backing frame for the louvered panels at the transfer truss level
Installing the standard panels on typical floors
Fixing detail of the panels
Fixing detail of the panels
Detail of the louvered panels
Exterior detail of the standard panels
Exterior detail of the standard panels
Elevation and sectional detail of typical panels
Enlarged detail of a typical panel unit
Storage arrangement of the panel units inside building interior
Close up of standard panels seeing the section and junction detail of the units
Stainless steel entrance canopy forming part of the building façades
Residential Development at Stubbs Road

- A 66-storey residential building with internal and external shear walls forming the major part of the building structure
Backing arrangement to the building exterior before the fixing of the wall panelling
Detail of the built-in anchor channel and the fixing bracket
Touching up of the window and wall units
Detail of the fixing at the rebate window
common problem sources where failures to
curtain wall often occur

Design failure – selection and appropriateness of the
system, non-compliance to design and performance
standards, imperfection in the jointing design and
detailing, improper use of materials etc.

Construction and structural failure – wrong location
or method of fixing, improper anchorage and
connection provision (including failure in welding),
failure in the walling components, unpredicted
deflection or deformation appears in the background
structure, poor supervision and workmanship.
Maintenance Consideration

common problem sources where failures to curtain wall often occur (cont.)

Aging and deterioration – discolouring and surface damaging due to weather action; corrosion due to air pollution, acid rain, or electro-chemical effect to dissimilar metals; aging and hardening of the glazing compound or sealing gasket, deteriorating of the insulating materials that lead to further dampening of the walling materials/components, disfiguring or loosening of the fixing and connections, loosening or broken-off of the glazing or other fitting items.
Maintenance Consideration

Signs to observed during maintenance inspection

- Sign of distress and deterioration of the entire wall system,
- cracked, loose or missing glass panels,
- bulging, bowing, separation, delamination, rotation, displacement of panels,
- marks of water, staining and rust,
- damaged and missing parts, corrosion, loosening or other defects,
- extrusion, wrinkle, split, missing or other signs of deterioration of the sealing materials.
- moisture appears around or behind the curtain wall.
End of presentation

and …

Sorry for the rough and not perfectly organized presentation. The Powerpoint was prepared in a very hurried manner.

If you wish to know more about the research output of the Author, you can visit Raymond’s Homepage at

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

Thank you