High quality facades custom designed for High rise buildings of Sri Lanka

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Abstract

This paper illustrates and shares the recent experiences on implementation of a Customized design solution specific to the building of Sri Lanka addressing local challenges, aimed to achieve high quality facades of international standards, yet economical and well designed to achieve faster construction.

1. Introduction

Building facades are increasingly becoming sophisticated and interesting adapting to modern building architecture and challenging requirements. Facades are receiving special attention in the construction industry as it is a specialized construction fields which has well adopted latest technologies. Façade designs, constructions, implementations are not set by any limitations or boundaries and thus leave opportunities for designers or owners to make their design ideas a reality. This paper focusses on the façade glazing systems being adapted for high rise buildings. Some of its latest trends in particular to tall buildings in Sri Lanka, has been completed recently or under construction.

2. Glazing Systems

There are several ways the systems shall be classified. However, from the construction point of view, following are the widely used glazing systems.

1. Stick Glazing system
2. Semi Unitised or Cassette system
3. Unitised system

2.1 Stick glazing system

Glass has been supported by Aluminium grid work framing system, vertical frames (called as "Mullion") spans between floors supported by brackets at each floor. Horizontal framing (called as "Transom") connected to verticals used to glaze the glass units. All materials are delivered as components to the project site and installations are carried sequentially. These types of systems are generally adapted for low rise buildings, small size applications, using standard available designs. This system is adapted for the basic requirements which do not require customized design solutions.

2.2 Semi Unitized system

Also known as Cassette system, this is similar to Stick system as defined above. However, the glass units are glazing with aluminium sash frames at factory and then delivered to the site. These glazed units are hooked on to the aluminium grid works erected at the site. Hence this system has less site works. All materials are delivered as components to the project site and installations are carried sequentially. This system has slightly lesser site works as compared to Stick glazing system. However, the system weather performances rely on site workmanship as it involves the primary sealing between glazing cassettes to be maintained with high integrity, so that no water or air enters the system.

2.3 Unitised systems

This employs most modern fabrication and construction techniques of pre-fabrication approach. The glazed panels are fully finished at the factory and delivered to the site and ready to be erected in place. This results in very little work at the site and achieves high quality and faster completion. In recent times, most modern buildings globally adapt this approach. These types of systems were implemented internationally and proven to be time tested design solutions without any compromise on quality and timeframe. The following sections give a detailed description

3. High rise design challenges

Facades for high rise buildings have specific design, few major aspects as tabled below.

Design	Weather	Site
• Structural • Visual architectural • Performances • Framings • Brackets	• Performances • Durability • Finishes • Corrosive environment • Local conditions	• Logistics • Access • Material handling • Site testing

Following are some key design principles which shall be focused by façade designers from engineering point of view.

- Direct load transfer
- Structurally efficient
- Allow movement / rotations
- Ease of fixing
- Simplicity in detailing
- Ability to interface cleanly with main building

3.1 Structural design aspects

Wind presses varying from normal to high and extreme pressures, and non-uniform pressures among various elevations; lead to challenges on achieving optimum design requirements balance between practical and technical aspects

3.2 Building movements

Following are primary aspects for the façade movements on tall buildings

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Sway or Inter-Story Drift: Horizontal or lateral movements at floor level due to wind or seismic movements. This will induce racking and in planar forces on façade panels.

Following shows typical panel deformation mode due to building sway. As a good design guidance, the façade systems is recommended to accommodate H/500 (H-floor height) lateral movement.

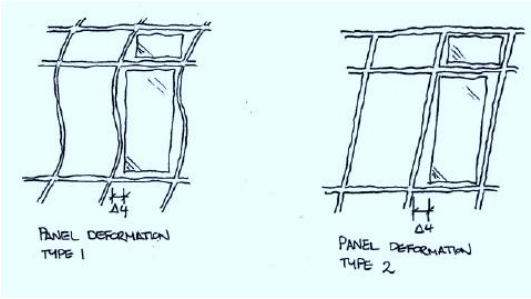

Figure: Panel mode of movement due to sway

Floor movements: Building floors may have different movement behaviours due to imposed load and other aspects. Hence it is recommended that the façade fixings and floor interfaces are adequately designed to address these movements. Ignoring this key design aspect may have adverse impact such as panel cracking or other failures. Following image illustrates a typical floor fixing which has vertical movement allowances.

Vertical movement happens here

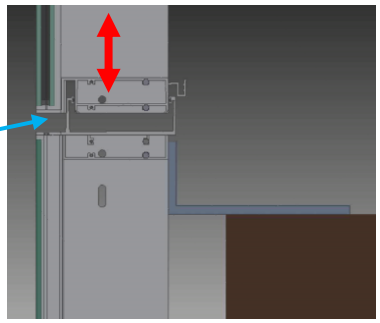

Figure: Typical floor bracket and Curtain wall profiles

4. Case Study - Grand Hyatt Colombo

On-going tall building in Colombo has successfully implemented the latest facade techniques on par with international standards which has achieved high quality and faster constructions. Facade of the building is nearing completion at this stage,

Following section elaborates the design and implementation strategy adapted-

Figure: Façade progress and a close-up view

***4.1** Design intent and requirements*

Large window system is required to cater several configurations of hotel levels. Windows are large and very different from conventional hotel rooms which fairly uses picture framed window concept. These window systems are designed to be installed from inside without requiring any external access. The external access for final sealing were managed by using gondola.

4.2 Key design principles

Following has been adapted as key design requirements, images below shows these with actual implementation.

- Design derived from the ease of implementation aspects
- Glazing system designed for the specific building condition such as floor edges and concrete frames.
- Aimed for faster installation and better site handling
- Expected to improve Installation safety and work sequences with other trades

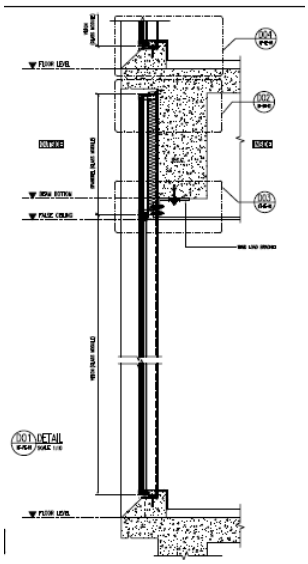

Figure: Design drawings by BES, actual site installation shows panels are handled and installed from inside

4.3 Facade system:

Glazing outline has been set to fit within a tighter space due to concrete ledge details. Resulted large framing systems are not possible to use. Hence a window wall system using Unitized approach is adapted as a highly efficient system. It has been noted that none of the standard proprietary glazing systems will satisfy the specific design requirements. Hence BES has proposed an innovative design solution adapting the panel / ribbon window concept that has been adapted for the Unitised (pre-fabricated) panel glazing system.

This has directly made positive impact on the façade works completed with high quality at lesser time frame. The overall systems including vision and spandrel units were fully fabricated (overseas) and shipped as ready to install glazed units.

All necessary brackets were pre-fixed at the site, bracket design and end jamb details were carefully designed to

accommodate and to adjust variable concrete openings dimensions and tolerances.

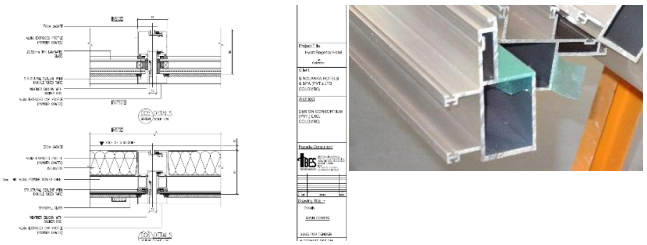

Figure: Typical façade system details of a customised system engineered and developed by BES, samples verified at the extruder plant

4.4 Testing and verification

The system has been tested at a third-party test lab to check if the structural and weather performances comply with International standards. Hence design and all technical aspects of the customized design have been verified prior to full scale implementation. BES has developed systematic quality checking methods which have been adapted by the glazing contractor and material suppliers.

Figure: Performance test mock-up – external and internal views

4.4 Installation technique adopted:
Access for all façade works were from inside, use of the Gondola access were limited for external sealing only. Glazing panels were hoisted using monorail fixed at higher floor. Hence overall installation has been coordinated and integrated for smoother and safer site works.

External access has been used for final sealing, this has helped site working sequences and resulted in no clashing with other agencies. External painting works has been completed by the main contractor using scaffolding which has no clash of works with facades.

5. Results and Discussion

Facades for high rise building often faces several design and implementation challenges; each building may pose specific sets of challenges. Hence designers should approach these requirements with an innovative and out of the box approach. Often the standard and readily available solutions may not be the most appropriate for that particular building requirements. Although readily available systems or proprietary products provide plenty of design solutions and products, they may not be the best solutions for challenging and complex requirements.

Key decision makers of the team shall explore ideas and analyze all available solutions with experts before deciding. Decision making should not be influenced by the availability or the fact that they have never been tried before locally. Furthermore, time tested design solutions though it may be new to the particular region or new to the local content. However, if the design solutions have been demonstrated as robust and most appropriate, these types of customized solutions can be trusted and expected to meet particular project requirements.

In this particular project, the customized design solutions have proven to be highly efficient and cost effective compared to other proprietary systems and have achieved high quality and successful results. BES has given technical expertise and appropriate technical guidance for the stack holders of the project to take right decisions which has made a positive impact on the project outcome.

References

The author wishes to credit the following stack holders of the project.

- Owner: Canwill Holdings (Pvt) Ltd / Sinolanka Hotels & Spa (Pvt) Ltd
- Architect: DCL (Design Consortium Private Limited), Colombo
- Hyatt Hotels Corporation - USA

Following are the project contractors

- Main Contractor: Maga Engineering
- Façade Contractor: Yanjian Group