

# Structural Design of a Glass Facade

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**Abstract-** Façade Engineering is the art of resolving aesthetic, environmental and structural issues to achieve the enclosure of habitable space. Today lightness and transparency are properties that both architects and clients try to obtain. This has rapidly increased the use of glass in facades. By using steel as a load bearing structure, it is possible to keep the transparency restricting structures slim. The aim of this master's thesis is to gather together information on research, design and codes about the structural design in steel-glass facades. The use of glass in facades causes many problems due to the material properties of glass. Glass differs from other building materials in aspect of being an extremely brittle material and breaking without a forewarning. This material property of brittleness has to be taken into account when designing large glass facades. The requirements of designing load-bearing structures are normally gotten from either the glass supplier or the producer of glass pane elements, who both are thereby responsible for the strength and functionality of the fastening.

**Index Terms-** Façade, Brackets, Load Bearing Structures, glass Façade.

## I. INTRODUCTION

Façade is a French origin word meaning the front face. The use of glass in the exterior facades provided more of light and good ambience to the occupant of the building which gave rise to the increasing use of glass. For the architectural point of view the use of glass gave aesthetic view to the building itself. A structure supported by aluminum frame work which is made up of Mullion and Transom is called as a curtain wall. Mullion is a vertical support or we may call it as a column, while the transom is a horizontal support likely to a beam. The first curtain walls were made with steel mullions, and the plate glass was attached to the mullions with asbestos or fiber glass modified glazing compound.

## II. TYPES OF CURTAIN WALL GLAZING

Curtain wall meaning a set of aluminum profile like Mullion, Transom, Glass panel.

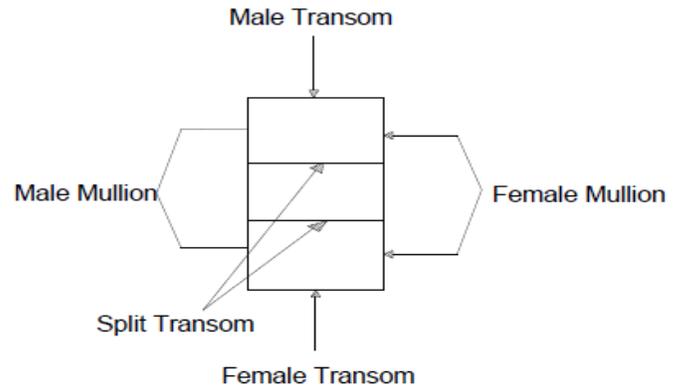


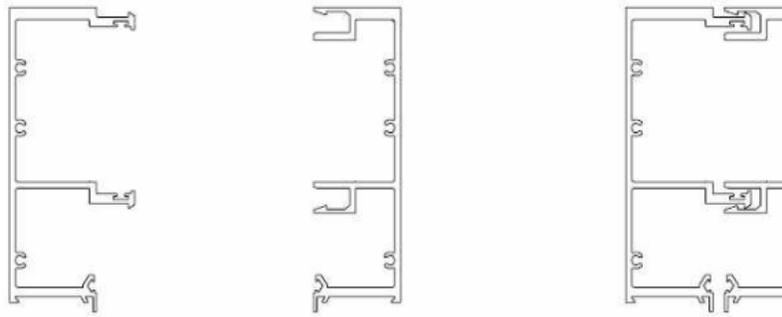
Figure: 1.1 Parts of Unitized System

There are three types of curtain wall

- 1.1 Stick System
- 1.2 Unit Panel System (Unitized)
- 1.3 Unit Mullion System (Semi unitized)

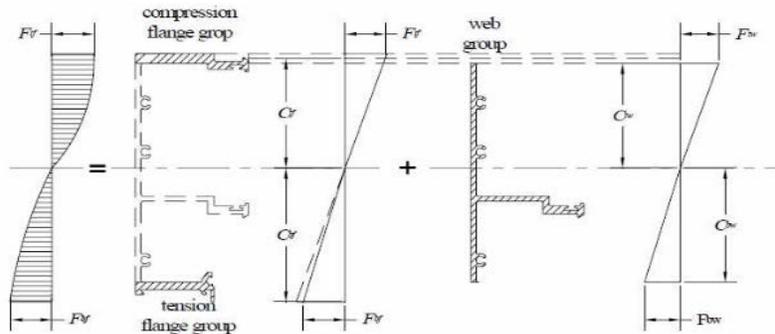
Above three we used the unit panel system which is also called as unitized system.

This system comes pre-assembled; it can be pre-glazed at the factory or shop, or glazed on-site. As such, it minimizes field labor and erection costs, and promises a shorter installation period than the stick system. Quality control issues can be significantly reduced in terms of site labor, especially with pre-glazed units, but assembly at the plant and transportation (due to bulk) increases its cost. Another disadvantage to pre-assembly is any site changes become difficult to accommodate. Assembly must be carried out in a specific sequence to ensure a proper fit. In a unitized system, the manufacturer must rely on qualified installers to ensure that the air seals are properly installed between the split mullions. Nevertheless, the unitized system is the most popular façade system according to manufacturer and it has performed satisfactorily when installed correctly.

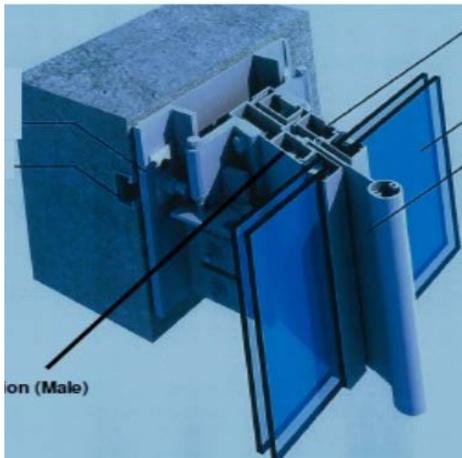


**Figure: 1.2 E-Type Unitized System**

Male Mullion and Female Mullion combine forms the unitized systems.



**Figure: 1.3 Assumption of Stress Distribution**



**Figure: 1.4 Fixing details of unitized curtain wall system**



**Figure: 1.5 Unitized Curtain Wall Panel.**

### III. STRUCTURAL DESIGN

The Curtain Wall is designed to resist and handle all the imposed loads on it as well as keep air and water from penetrating in the building. The loads imposed on the curtain wall are transferred to the building structure through structural interface (i.e. brackets) which attaches the mullions to the building. The curtain wall is designed for the following Loads.

1. Dead Load
2. Wind Load

#### Applicable Standard Codes

IS 875-1987 (Part -1 Dead Loads) Indian Standard Code of Practice for Design  
IS 875-1987 (Part -3 Wind Loads) Indian Standard Code of Practice for Design

IS 8147-1976 Indian Standard Code of Practice for use Aluminum alloys  
 IS 800-1984 Indian Standard Code of Practice for general construction in steel  
 Software's used for Analysis & Design:

STAAD Pro V8i (For Structural Analysis)

WIND PRESSURE CALCULATIONS FOR FRAMING

A) Building Parameters :

Length	l	52500	mm	Ratio		For External Pressure
Width	w	16150	mm	h/w	3.56	Coefficient from Table-4 of
Height	h	57475	mm	l/w	3.25	IS 875-Part3

Typical Mullion Analysis

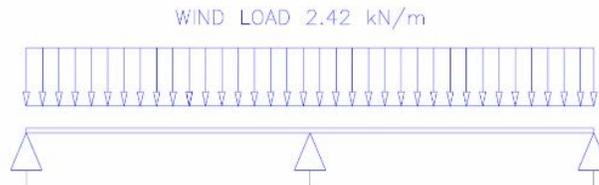


Figure: 1.6 UDL Due to Wind Load

Max Span (L) = 3.65m  
 Max Cross Span (S) = 1.05m  
 Number of transom per unit = 2  
 Max BM = 4.02 kN/m  
 Deflection Calculation of Mullion  
 Max Deflection = 6.11mm ..... From STAAD PRO  
 Permissible Deflection (Lesser) = Span/175 = 20.86mm or 19mm  
 Therefore Max deflection = 19.00mm  
 > 6.11mm

From STAAD Results

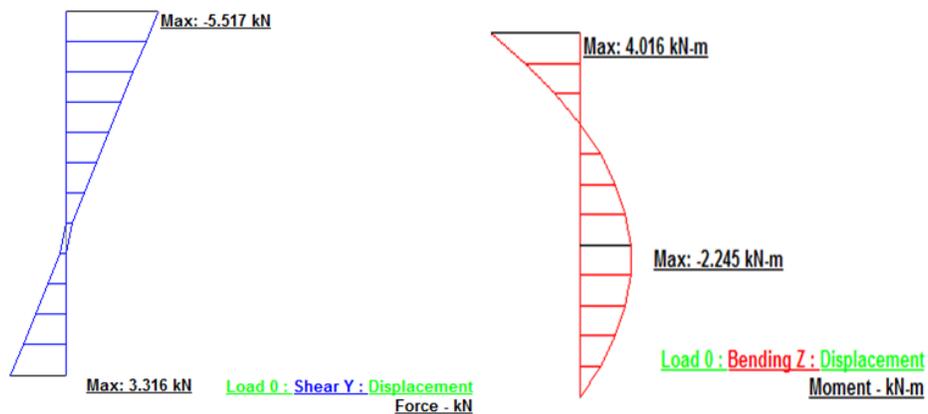
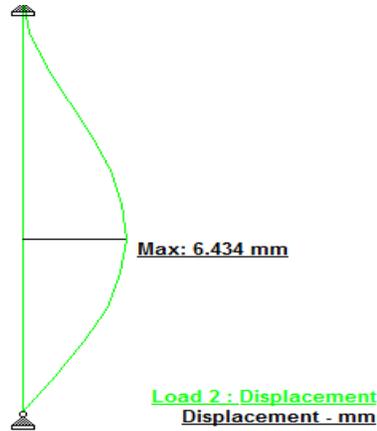


Fig:1.7 Shear Force Diagram For Mullion Fig: 1.7 Bending Moment Diagram For Mullion



**Figure: 1.8 Deflection Diagram For Mullion**

**Design of Glass: Using Code ASTM 1300**

Glass module: 1.05m (a) x 1.220m (b)

Type of Glass = (10mm) + (12mm Air Gap) + (6mm)

Wind load = 2.305 kPa

The max centre deflection of the glass = 4.00 mm

Max allowable centre deflection of the glass = Span / 90 or 25mm whichever is less

= 1050/90 = 11.66 mm

**Base Plate Design**

Width (B) = 300 mm

Depth (D) = 300 mm

Thickness = 8 mm

Max BM = 0.46 kNm (BM/2)

**Check For Connection Bolt**

Max Vertical Shear Force = 2.6 Kn (V)

Max Horizontal Shear Force = 2.6 kN (H)

Resultant max shear (V) = 5.7 kNm

Check for mullion bending stress

Min Thickness = 2.5 mm

Dia of hole = 11.5 mm

No. of bolts = 2

No. of interference = 2

Bearing Stress = 49.14 N/mm<sup>2</sup>

Permissible bearing Stress (6063 T6) = 139 N/mm<sup>2</sup>



**Figure: 1.9 Ex. Of Glass Façade building**

#### IV. CONCLUSION

1. Glass has become a major element in designing modern commercial or public buildings. Load-bearing structures are wanted to be delicate systems with a transparent feel.

2. The use of steel in load-bearing structures improves the transparency of facades because it has been possible to keep the load-bearing structure slender.

3. The main aspect in designing steel and glass joints is to consider the special material properties and behavior of glass.

4. Glass fractures brittle without a forewarning. These properties and behavior concern normal float glass as well as laminated glass and safety glass.

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