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Outlines of the course:

Lecture 1: Curtain wall design -- General
-Speaker: Dr. Wilson ZHOU

1. The current status of curtain wall designs in HK and in the world.
2. The tendency of the development of curtain walls.
3. Stick system: a) Typical and various design of a mullion section.
   b) Typical and various design of a transom section.
   c) Typical and various connections between the mullion and the transom.
   d) Typical and various fixing of the glass panels to aluminum frames.
4. Semi-unitized system: a) Glass glazed in factory.
   b) Installation of the glazed unit to aluminum frame on site
5. Unitized system: a) Typical and various design of a split mullion.
   b) Typical and various design of a transom at stack joint.
   c) How to apply the pressure equalization principles.
   d) Do we need holes in mullion to "ventilate the space in transoms or spandrel areas?
   e) When should sealant be used? When can the gasket work and provide water tight system?
   f) A design using stack joint at wrong positions (two pins for one unit or one pin and one simple support.)
6. Performance tests for curtain walls.
7. General problems encountered during curtain wall testing.

Lecture 2: First section – Design using Glass
-Speaker: Dr. Wilson ZHOU

1. The types of glass (tempered glass, Annealed glass, Heat strengthened glass, Laminated glass with PVB or SGP interlayers, Wired glass etc.) that are used on curtain walls and windows etc. (what is the "surface compression" of the heat-treated glass)
2. The selection of the right type of glass structurally and/or to Glass Code 2018.
3. Calculation with Timoshenko formulas, using diagrams in BS 6262 or AS/NZS 1288 or ASTM E1300 or,
4. Calculation using Glass Code 2018.
5. Load sharing among the glass layers in laminated glass or in double glazing glass.
6. Composite action for laminated glass using PVB interlayer and using SGP interlayer. (The test to determine the degree of composite action)
7. Allowable stresses (and design strengths) for each type of glass in the centre and on the edge.
8. Allowable stresses for glass fin.
9. Installation of the glass panels.
10. Different causes to glass breakage. (Can we identify the tempered with a risk of spontaneous breakage?)

Second section -- Aluminum Design
-Speaker: Dr. Wilson ZHOU

1. Types of aluminum alloys. Which type(s) are adequate for curtain walls or aluminum claddings?
1. Limiting state design for aluminum to BS 8118.
2. Calculation of a mullion using formulas, or using software.
3. Calculation of a transom (triangular loading, trapezoid loading).
4. Calculation of a screw.
5. Allowable stress in an aluminum section, checking buckling of an aluminum section.
6. Determination of wind pressures on a curtain wall

Lecture 3: First section -- Design using sealant & gaskets

-Speaker: Dr. Wilson ZHOU

1. Sealant types (weather sealant and structural sealant, fire resistant sealant etc.)
2. Allowable stresses for a sealant.
3. Calculation of a sealant bite for panels of various shapes.
4. Sealant tests.
5. Gasket types.
6. Durability of gaskets
7. Different gasket profiles & functions
8. Gasket pockets – size matters
9. Selection of setting blocks underneath a glass panel.

Second section – Design using screws and rivets

-Speaker: Dr. Wilson ZHOU

1. Screws to be s/s or aluminium alloys to avoid rusting stains.
2. Section areas for rivets are smaller than nominal noticing the hollow section of the rivet.
3. Rusting caused by s/s screws to aluminium at screw holes, and how to prevent.
4. How to reinforce a screw fixing at screw holes (in aluminum section) where hinges are installed?
5. How to calculation a screw?
6. How to avoid screw from being pulled out of the screw hole.

Third section – Design of aluminium windows

-Speaker: Dr. Wilson ZHOU

1. Names for the element of an aluminium window.
2. Typical window sections.
3. Typical side fixings – metal lugs, anchor bolts + steel plates, embeds etc.
4. How to calculate metal lugs.
5. How to avoid the drive pins being pulled out from concrete.
6. Proper use of four-bar hinges
7. Multi-point locks – how to avoid the lock points from slipping off the keepers?
8. Case study 1: why did a four-bar hinge fail (90% bars of the hinges deformed)?
9. Case study 2: why did a window (faking a curtain wall) leaks water so easily?

Lecture 4: First section – Design of stone claddings

-Speaker: Dr. Wilson ZHOU

1. Fixings: anchor bolts or embeds
2. Can pin be used (into the stone panels)?
3. How to use butterfly brackets?
4. How to calculate the stone at pins?
5. How to calculate the stone at brackets?
6. Should mid-span support be used to reduce the bending stress in a stone?
7. Allowable bending strength of stones, tests to determine this strength.
8. Allowable shear stress of stones, tests to determine.
9. Can epoxy be used to fix stone panels? What should be considered?
10. Case study: why did stone panels (fixed with back-inserted bracket and epoxy) fall off from a high rise building?

Second section -- Design of Glass walls

-Speaker: Dr. Wilson ZHOU

1. Design of glass walls with spiders and a truss system.
2. Design of glass walls with spiders and pretension wires.
3. Design of glass walls with glass fins as the structure.
4. Structural calculation for glass fins: lateral buckling and how to avoid.
5. What is the allowable bending stress for a glass fin?
6. Do you need weep holes at the bottom of a glass wall?
7. Selection of glass for the glass walls.
8. How to achieve a sealant bite needed at glass butt joints.

Lecture 5: First section – Design for canopies & skylights
-Speaker: Dr. Wilson ZHOU

1. Typical fixing of glass panels to aluminum sections
2. The fixing design for a horizontal skylight shall not be applied to an inclined skylight. (where dead load could be supported improperly)
3. Selection of the right glass type.
4. How to avoid glass breakage on a canopy or a skylight.
5. How to determine the wind pressures on canopy or a skylight.

Second section – Glass balustrades & louvers
-Speaker: Dr. Wilson ZHOU

1. Various bottom fixings for free-standing glass balustrades.
2. Risk in using plaster-filling for the bottom fixing of the glass.
3. Loads on the free-standing glass (Imposed or wind-induced)
4. Design for the louver blades
5. How to calculate free area ratio?
6. How to determine the effectiveness of a louver by tests?

Third section – Design using steel and stainless steel
-Speaker: Dr. Wilson ZHOU

1. Steel types and how to define.
2. Why stainless steel on building facades?
3. When and where to use stainless steel?
4. How to protect steel from rusting?
5. Bimetal effects between different metals (aluminum/with steel or aluminum/ with s/s), and how to isolate them.

Lecture 6: First section – Calculations for building façade system (summary)
-Speaker: Dr. Wilson ZHOU

1. Calculation for steel - limiting state loads on building façade systems for steel design and material factors for steel to "Structural Use of Steel , 2011"
2. Calculation for aluminum - limiting state loads on building façade for aluminum design & material factors.
3. Calculation for glass - loads to be adopted for glass design
4. Calculation sample for an embed
5. Sample calculation for a steel, aluminum bracket.

Second section – Case study for unitized curtain walls
-Speaker: Dr. Wilson ZHOU / Mr. Edmond MA

First case – a system we designed:

a) Coupling of the male/female mullions (details)
b) Coupling of transoms at stack joints (details)
c) Gasket profiles adopted (details)
d) Performance test conducted (Photos)
e) Curtain wall installed (Photos)

Second case – a unitized curtain wall for a building in Hong Kong installed 20 years ago:

a) Coupling of mullions – gaskets as water barriers
b) Coupling of transoms at stack joint (gaskets profiles and positions).
c) Why were there water leakages?
d) Possible improvements to gaskets design.
e) Water barriers are to be put at the right positions.

Lecture 7 Wind Loads and BD submissions

First section

- Wind effects on building - an introduction to the use of

Wind Code HK 2019- how to use it

a) Net pressure on facade: P = Qz Cp Ss
b) Qz – reference pressure; Cp – pressure coefficient; Ss – Size factor
c) $Qz = Q_{0,z}\, S_t\, S_\theta$ etc.
d) All items defined correctly.
e) Size factor correctly used for the calculation for various elements.
f) Cp on a podium
g) Edge zones

2nd section: BD submissions

a. BD submission for new designs for curtain walls etc.
b. BD submission for minor works Class I
c. BD submission for minor works Class II

Lecture 8 Inspection for curtain wall and other façade systems

1st section:

What is to be inspected

Curtain Wall:

1. Glass: cracked, scratched, displaced?
2. Screws: rusted, broken or missing?
3. Sealant detached, cracked, penetrated with hole or missing?
4. Aluminum capping: deformed, disengaged or rusted?
5. s/s capping: deformed, disengaged or rusted (low grade s/s)?
6. Visual Inspections (plus relevant tests) on curtain walls.
7. Can infra images be used to inspect the curtain walls?
8. Can we rely on drones to inspect curtain walls?

Stone cladding:

1. Stone panel: Cracks (especially the cracks around the supports), natural fissures, holes,
2. Fixings: Cracks (especially the cracks around the supports).
3. Type of fixings: which may lead to what kind of failures?

Louver:

1. Water leakage: usually through it due to the water catching system at the bottom fails
2. Rusting to the steel screws etc. exposed.

Windows:

1. Hinges: Four bar hinges, pivot hinges.
2. Locks and keepers

Case studies:

1. Case 1: missing Flashing on the head of a window (faking CW);
2. Case 2: A hole in system behind a louver
3. Case 3: broken stone panel at back inserted bracket
4. Case 4: water leakage due to incorrect use of “pressure-equalization”