# 1.0 ARCHITECTURE

## 1.1 SITE DESIGN

## 1.2 ARCHITECTURE DESIGN

## 1.3 FAÇADE

### 1.3.1 INTRODUCTION

The following Design Report has been prepared by the Design Team to describe the cladding design and related performance requirements for the project.

The First Academic Building is envisioned to be a sustainable building aiming for a LEED Platinum certification. The façade design plays an important part in passive energy conservation demanding R-values, which meet or exceed code requirements for the opaque areas and which require careful consideration of the overall glazing percentage over the building exterior. Exterior shading systems are located on the East facade to help balancing daylight harvesting against cooling demands and to minimize mechanical systems around the perimeter.

Apart from the above there are a number of important design criteria that are specific to this site and to this building, which have been included in the performance requirements of the cladding. These include:

- Review of environmental conditions which could lead to condensation
- Location adjacent to the sea requires corrosion-resistant materials and control of the building envelope

This document is an outline of design issues and proposed responses which affect the design. These issues comprise:

- Selection of wall types
- Definition of related thermal performance criteria
- Coordination of architecture, cladding, and structural geometries
- Design methodology of cladding components to accept structural movements and tolerances
- Design methodology of cladding components to comply with code requirements for fire protection
- Design of systems to enable competitive procurement of products
- Evaluation of the risk of condensation

The sections of this report are organized to discuss the above issues.

### 1.3.2 DESIGN CRITERIA

<u>Design Standards, Codes and Documents</u>

The façade design will refer to the following standards and codes:

- New York City Building Code
- New York City Energy Conservation Code
- AAMA Design Guidelines
- Aluminum Design Handbook
- Applicable ASTM standards
- ASTM 2813-12 Standard Practice for Building Enclosure Commissioning
- ASCE Standard 7-05 Minimum Design Loads for Buildings and Other Structures

- ASHRAE Fundamentals Handbook
- ASHRAE 90.1 Energy Efficiency Standards (2007)
- Dow Corning Structural Silicone Guidelines and Recommendations
- GANA Design Guidelines
- National Fenestration Rating Council (NFRC)
- Insulated Glass Manufacturers Alliance (IGMA)
- Society for Protective Coatings (SSPC)
- ASIS International
- American Institute of Steel Construction (AISC)

Load Combinations

The ASCE 7 provides for the use of Allowable Stress Design when calculating cladding loads. The applicable load combinations used for the vertical cladding elements of this project are as follows:

Table 1. Applicable load combinations, based on ASCE 7-05, Section 2.4.1

| Case | Load Combination |
|---|---|
| 1 | $D$ |
| 2 | $D + L$ |
| 3 | $D + (L_r \text{ or } S \text{ or } R)$ |
| 4 | $D + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$ |
| 5 | $D + (0.6W \text{ or } 0.7E)$ |
| 6a | $D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R)$ |
| 6b | $D + 0.75L + 0.75(0.7E) + 0.75S$ |
| 7 | $0.6D + 0.6W$ |
| 8 | $0.6D + 0.7E$ |

Key to abbreviations:
$A_k$ = load or load effect arising from extra ordinary event $A$
$D$ = dead load
$D_i$ = weight of ice
$E$ = earthquake load
$F$ = load due to fluids with well-defined pressures and maximum heights
$F_a$ = flood load
$H$ = load due to lateral earth pressure, ground water pressure, or pressure of bulk materials
$L$ = live load
$L_r$ = roof live load
$R$ = rain load
$S$ = snow load
$T$ = self-straining load

$W$ = wind load
$W_i$ = wind-on-ice determined in accordance with Chapter 10

The load combinations listed include dead, live, wind, ice, and earthquake loads. For all of the cladding components, the worst case of all load combinations will be used as the primary design load. The following sections describe in detail the criteria used to derive each of the loads.

Dead / Gravity Loads

All cladding systems shall support their self-weight and transmit this weight safely back to the supporting structure without overloading or permanently displacing any of its components.

Snow / Ice Loads

The façade shall sustain any loads created by snow and/or ice and shall transmit these loads back to the supporting structure safely without overloading or permanently deforming any of its components. Snow load shall be calculated in accordance with ASCE 7, as referenced in Section 2.1.

Live Loads

Where façade systems may experience maintenance access, they should be designed to accommodate such loads.

Wind Load

Wind loads for this project have been calculated based on a basic wind speed of 98 mph as per NYC Building Code and can be found in the structural section of this report.

Seismic Load

Based on preliminary load estimations, seismic acceleration forces on cladding elements will be less than wind loads. The seismic sway values can be found in the structural section of this report.

Thermal Load

Each cladding system shall accommodate displacements resulting from changes in temperature in any of its parts or supporting framework without any reduction in the performance. The following preventative measures will be taken by the contractor:

- Ensure that no glass or glazing combination develops stresses that may lead to damage of glass, glazing materials, components and/or framing systems
- Conduct a thermal stress analysis, undertake thermal calculations, and make due allowance for any heat-treated glass which may be required, and submit these for review
- Take into account shading stresses that might occur from adjacent components and buildings including shading devices

<u>Flooding and Wave Action</u>

Glazed façade areas only occur above the FEMA flood line. The design of the storefront areas at the first floor will therefore be designed for typical conditions with drainage at the base only.

<u>Deflection Limits</u>

All cladding systems shall be designed to accommodate the movements noted below without reduction in performance:

- Deflections due to design dead loads and live loads
- Deflections under repeated cycles of the design wind loads
- Changes in dimension and shape arising from specified building movements, including settlement, shrinkage, elastic shortening, floor beam deflections, creep, wind sway, twisting and racking, and thermal and moisture movement
- Deflections due to movement of any joint in the supporting structure or building frame

All systems will be designed in coordination with the structural engineer to allow for the following maximum deflections.

<u>Deflection limits for design of Façade Elements</u>
The design has been based on deflection limits as follows:

- Elements supporting plaster, masonry or brittle items: span/720
- Cladding framing: span/175
- Edge deflection for IGU's: span/175
- Metal panels: span/90

<u>Movements imposed by Building Structure on to Façade Elements</u>

The edge beam deflection limits will be coordinated with the structural engineer. EWS-1, the vertical wall at the upper floors, is a panelized system of 10' wide panels and will be dead loaded/hung from the floor slab with lateral connections at lower floors.
The storefront and curtain wall systems will be designed to accommodate the edge beam deflection in movement joints.
The movements that will need to be accounted for include:

- Maximum total vertical deflection, dead load, super imposed dead load and live load
- Maximum differential vertical deflection
- Maximum inter-floor sway
- Column shortening

<u>Environmental Conditions</u>

Façade performance have been assessed per the external design conditions given in the ASHRAE Handbook. Condensation resistance of typical details have been checked for the worst case (winter) condition.

Waterproofing Design

All cladding systems, including all joints between the systems composing the building skin, shall prevent water penetration into the interior of the building from the outer face of the assembly, under wind pressure, kinetic energy, gravity, surface tension, or capillary action. It shall also prevent water from entering into those parts of the cladding that would be adversely affected by the presence of water.

Performance requirements include:

- Air and vapor seal continuity, especially critical to the areas where the façade system meets the slab and joins into other façade systems
- Employment of a silicone gasket as a rear air and water seal and a gasketed front pressure plate and cap, acting as a rain seal
- The construction of a custom sub sill, sub head and sub jambs to create an end dam and tray under the sill extrusion, to catch and drain any water entering the system
- Weep holes directing water from aluminum channels out towards the front face of the glazing
- Structurally glazed units with gaskets acting as a rain deterrent between units

Condensation Control

Internal surface condensation can, in general, be dealt with in several ways:

- Improved thermal insulation of vision and framing systems
- Active monitoring and control of internal space conditions via the mechanical system
- Management of condensation through drainage systems
- Local heating of the façade through heat tracing, or radiators

Condensation occurrence, if frequent, can lead to a variety of building and maintenance issues. These can include increased maintenance due to staining, organic material degradation, water accumulation on floors and sills, and the potential for microbial growth. Infrequent occurrences of condensation (primarily due to non-typical weather) generally result in periodic increased maintenance and temporary aesthetic issues.

Vapor Barrier and Air infiltration

The system has been designed to limit air permeability and implements a continuous vapor barrier to avoid the flow of moisture between interior and exterior.
The façade sections and details have been designed to allow for an adequate and continuous vapor barrier.

Vapor control layers shall maintain their performance and properties for the expected service life of the system. They shall resist the deleterious effects of water vapor, temperature variations expected from the specified temperature ranges, gaseous pollutants (including ozone), weak acids derived from gaseous pollutants dissolved in water, and UV radiation to which they may be exposed during installation and in service.

Thermal Performance

The environmental conditions of the site and energy goals necessitate a high-performance façade from a thermal perspective. This is aimed at increasing the insulation value of each assembly and to avoid the instances of condensation formation on surfaces inboard of the vapor barrier.

The thermal performance of the vision area of the façade can be described in terms of two parameters:

- Insulating performance (U-value)
- Solar control (SHGC)

The performance of opaque areas can be solely described in terms of thermal performance. The required values of these parameters will be determined through a combination of the following:

- Energy code compliance commensurate with LEED Platinum aspiration
- Condensation mitigation
- Mechanical requirements

U-values for façade systems have been determined through analysis in Therm, which is a heat transfer modeling software by Lawrence Berkeley National Laboratory (LBNL) using NFRC boundary conditions. The analysis is based on finite-element method to determine the performance of different wall systems taking cold bridges (frame effects, edge effects) into account.
The SHGC of the glazing is determined through analysis of the low-E coating selection and glass make-up in LBNL software Window and includes frame effects for each glass type.

The minimum performance of the different wall types can be found in the exterior wall type and exterior glass type matrix, part of the submitted drawing set.

Prevention and/or reduction of condensation formation are linked directly to the U-value of the façade systems. Typically the area of concern is located around the vision panels, specifically at the framing and around rough openings.

Mechanical requirements are those specified by the mechanical consultant, to which their system is designed. Insulating performance relates to the size of the heating system, while the solar control of the vision areas impacts the size of the cooling system.

Acoustic Criteria

The transmission loss for different glazing systems is dependent on the damping in the glass, gap width, and glass thickness. Glazing needs to reduce intrusive noise to an acceptable level. This level is often based on two primary elements:

the outside sound levels that can be heard at the relevant site and elevation, and the noise criteria desired within.

Depending on the use of the space and the exterior conditions, different acoustic requirements have been determined for the wall types at vision areas and opaque zones. This is described in the acoustic section of this report and in the exterior glass type matrix.

Fire Performance Criteria

In general, fire and life safety provisions will be in accordance with the requirements of NYC Building Code. The Design Basis Memorandum must be followed in conjunction with the governing codes and standards:

- Occupational Health and Safety Act – Regulation 692, Industrial Establishments
- NFPA (National Fire Protection Association) Codes and Standards

The following fire protection assumptions and strategies have been used:

- Fire stop and smoke seals to be inserted between the edge of floor slab and the different wall systems

The architect is responsible for verifying the fire rating required for above points and confirm that there are no particular requirements for fire insulation where internal partitions meet the curtain wall or for any area of egress at the building perimeter (fire refuge).

Lightning Protection and Grounding Performance

The facade contractor shall coordinate as necessary with the contractor responsible for the lightning protection systems and shall agree appropriate connection points with him for review by the architect. All metallic framework elements and supporting structures of the façade shall be electrically continuous for the purposes of the lightning protection and grounding performance. No external tapes or visible connections will be accepted.

Cladding Life Expectancy

We assume that the target design life for cladding elements will be 25 years. This means that cladding elements should still exhibit most of the design performance characteristics after 25 years of operation assuming that adequate maintenance has been carried out. Suppliers' warranties for materials typically range from 5 to 15 years, though we would expect the design life to be greater than these periods.

The following façade materials would have expected life spans as follows:

- Gaskets: 10-30 years
- Paint finishes: 20-40 years
- Insulating glass: 20-30 years
- Silicone seals: 30-40 years

Maintenance

For an advanced façade system, appropriate maintenance is critical for keeping the system working properly.

For an expected design life of 25 years, ongoing maintenance must be carried out. This will include such actions as cleaning, re-coating, replacement of gaskets and seals, and replacement of glazing. Inappropriate maintenance will accelerate the deteriorations and shorten the design lift.

### 1.3.3 WALL TYPES

A full overview of the wall type build up and performance requirements for each system can be found in the exterior facade type matrix and the exterior glass type matrix, part of the submitted drawing set.

EWS 1: Vertical wall at work spaces

EWS-1 consists of a panelized stud-wall system. The weather wall assembly consists from inside to outside, of: interior finish, cold formed steel framing, exterior sheathing, continuous air- and vapor barrier and insulation. Outboard of this weather wall portion, metal cladding panels in a rainscreen application are supported of brackets from the cold formed framing. Coupled aluminum sections are used to join the unitized panels with two sets of engaging extrusions to define both an inner and outer pressure equalized chamber. The assembly is hung from the floor slab with a top-of-floor anchor.

Insulated glazing units are structurally glazed onto aluminum extrusions. The window frames are inserted into the cold formed framing. Solar shading is provided by exterior metal cladding panels cantilevering in front of the window openings.

EWS 2: Atrium

The vertical wall at the atrium consists of a curtain wall system of 14’ tall by 5’ wide. Each 14’ tall system is subdivided by a transom into two glazing units of 9’6” tall by 5’ wide and 4’6” tall by 5’ wide that are structurally glazed onto aluminum extrusions. The panels are suspended from horizontally spanning structural steel tubes at floor slab locations.

EWS 3: Storefront at first floor

The storefront at the first floor consists of a unitized aluminum storefront system of 10’6” tall by 5’ wide. Insulated glazing units are structurally glazed onto aluminum extrusions.

EWS 4 and 5: Curtain wall systems

The fourth floor at the south and west façade as well as the reveal spaces at the North and South façade are designed as curtain wall panels with structurally glazed units. The profiles are pressure equalized to the rear air seal of the system.

At spandrel zones the panels contain a shadow box with insulation and a metal backpan. The spandrel is pressure equalized to the backpan and wept.

EWS 6: Vertical wall at mechanical penthouse

The mechanical penthouse will have mechanical louvers at air in- and outlets. Blank-off panels with metal louvers are located at inactive sections of the wall.

### 1.3.4 MATERIALS

Aluminum

All extruded aluminum shall be 6063-T6. Stronger alloys and tempers may be used where required, subject to approval.

Finishes
The following metal finishes are provided with information regarding general durability performance:

- Kynar – Can provide additional coatings to enhance salt resistance and maintain same 15+ year warranty
- Powdercoat - Can provide additional coatings to enhance salt resistance and maintain same 15 year warranty
- Anodized – Class 1 finish is recommended for coastal environments; will typically not provide a warranty of more than 5 years regardless of location

Steel

Unless noted otherwise, structural steel shall be Grade 46 for tubes, Grade 42 for pipes and A572 Grade 50 for all rolled shapes and connections, in accordance with ASTM standards.

Due to the large spans of the cladding elements, it is recommended that tolerances smaller than that of typical structural steel be specified. Note that AESS tolerances are half of that of typical structural steel as per AISC.

In selection the material for the metal panels consideration will need to be given to the marine grade environment on Roosevelt Island.

Finishes
Steel mullions, transoms, and plates should be coated with zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00, and applied immediately after surface preparation and pretreatment. Surface preparation methods should be selected based on recommendations in SSPC-SP COM and applicable to SSPC standards.

Steel mullions and transoms should be finished as follows:

- Mild steel components shall be hot-dip galvanized after forming and drilling. The cutting, drilling or working of galvanized components should not be permitted.

- The galvanizer should control dipping rats to ensure distortion is minimized, and cracking due to differential expansion is avoided.

All galvanized components should be subject to the following inspections to ensure freedom from cracking:

- 100% visual inspection
- Magnetic particle inspection of areas indicated on the architect's drawings

All inspections should be recorded, and any cracked components shall be rejected. Cut ends or surface working to pre-galvanized sheet steel, or any damage to galvanizing (hot-dipped or otherwise) should be repaired with zinc rich paint complying with AWS C2.18 / ASTM C 633. Two coats of paint should be applied over galvanizing with color and gloss as selected by the architect.

<u>Glass</u>

The project goals for Cornell NYC Tech First Academic Building include a focus on energy performance, and as a result, high-performance glazing has been selected. The selected glazing will obtain low U-values and solar gain coefficients, while maintaining visible light transmittance. The performance values have been coordinated with the project mechanical engineer.

The current basis of design for the vision areas is a double-glazed, insulated glazing unit, utilizing a high performance low-e coating. Low iron lites are to be used. The interstitial space is filled with Argon. The specific makeup required for each system may be found in the exterior glass type matrix, in the submitted drawings set.

<u>Structural Silicone Glazing</u>

Structural silicone glazing is to be applied under factory conditions wherever possible.

The recommended application procedures of the structural silicone manufacturer shall be strictly followed. This should include:

- Review of proposed structural silicone design details
- Compatibility testing of the structural silicone with other materials with which it will come into contact
- Substrate cleaning/priming
- Joint filling and tooling
- Production deglazing and material testing

Upon completion, 100% visual inspection of all structural silicone joints shall be performed.

### 1.3.5 ACCESSORIES

Cladding accessories include fasteners, gaskets, tapes, sealants, adhesives, etc. The main issues for the accessories are corrosion control and material compatibility. When dissimilar metals are in contact, isolation should be provided between areas in contact to prevent galvanic action.

Fasteners

Due to the marine environment any exterior fasteners or fasteners in wet areas shall be stainless steel or be weather coated for corrosion resistance.

Gaskets

Given the proposed design life, extruded silicone gaskets will be used. Gaskets shall be free from contact and migration stain, and shall be compatible with all substrate, sealant, and finishes with which they are likely to come into contact.

Weather Sealants

Weather sealants shall comply with AAMA guidelines and be low modulus such as Dow Corning 795/793/791. The color of visible sealant used shall be as specified per the architect's drawings.

### 1.3.6 MOCK-UPS AND TESTING

Visual Mock-Ups

Visual mock-ups are intended to provide the design team with an approved aesthetic and final material selection in addition to samples. A visual mock-up is recommended to be built at the early stage of the project before more detailed work is carried out. The mock-up shall be composed to evaluate as many junctions and typical conditions as possible.

Visual mock-ups are built to verify selections made under sample submittals, to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

Performance Mock-Up Testing

The design of custom and critical cladding elements shall be verified by full scale mock-up testing. Testing should be carried out at an approved independent laboratory, or under the supervision of an approved independent laboratory. The erection of mock-up at the testing laboratory shall not commence prior to review and acceptance of the laboratory's proposed test procedure by the architect.

Performance mock-up will be carried out during the contracting stage at or by a certified laboratory. The areas to be tested should be defined in the contracting documents and become part of the contracting package.

Ideally, the mock-ups will be constructed by the same crew that will install the cladding on the project. The performance mock-ups can also validate the method of construction.

Structural Silicone Glazing – Fabrication Quality Check

A Quality Assurance scheme to the approval of the structural silicone manufacturer is to be implemented for all elements relying on structural silicone glazing. This will include periodic factory and site deglazes and adhesion testing under the supervision of the structural silicone manufacturer.

On-site Hose Testing

All cladding systems are to be hose tested according to AAMA 501.2.

Allow for testing of at least 5% of each cladding type. In the event that leaks are found, they are to be repaired and a further 5 panels shall be hose tested over and above the base 10% of panels. For stick and/or cassette systems, allow for 50% testing.