Wall Module

THE INTEGRATED FACADE

The necessity to off-site building construction has long been to separate the structure and facade of the building processes into two distinct components, requiring two trades working on-site and two steps to the construction process. For the CFR, the structure and facade is combined in the factory and delivered to the site as a complete single wall unit. As the perimeter columns and spandrel beams are being lowered into place, so are also the glazing, shading, and facade systems—a clear, single-step process to erect a dried-in building. The columns and spandrel beams that make up each structural bay (say, 4 x 4 floors) are precast as continuous frames that are then filled with the latter building insulation technology—specifically conceptualized for the site conditions and wall orientation. The building facade of the CFR is designed using high R-value materials, such as multiform made of pultruded fiber-reinforced polymeric composites (FRP), which is fiberglass that has been formed into linear components to replace extruded aluminum, triple-pane glass, or insulating glass units and window locks and frames isolating panels using argon, interspersed to reduce loads. Solar radiation is blocked by large vertical shading devices and converted to electric energy with translucent amorphous silicon photovoltaic cells. In an effort to minimize the interior space glazing, perimeter columns are shifted to the exterior of the wall—these internal precast elements will be cast with integrated insulation to prevent thermal bridging to the interior.

01 High-Strength Pre-cast Concrete Frame
02 Triple Glazed High Efficiency Vision Zone
03 Pultruded Fiber-Reinforced Polymer Composite Mullion System
04 Translucent Fiberglass Panel With Argon Fill
05 Computer-Synchronized Operable Window For Airflow
06 Cast-in Structural Mounting Stem
07 Photovoltaic Integrated Vertical Sunshades
Central Core Module

RETHINKING THE CENTER

In a conventional office building, the core is typically a tightly packed conglomerate of large structural members for lateral support and utilization programmatic spaces, such as stair shafts, mechanical rooms, and restrooms. It is generally treated as a necessary yet mundane grouping of spaces located in the center of the floorplate and shielded from natural light. The CRF will define a new paradigm, one that reimagines the core as the heart of the building, a varying open space. Rather than group all of the lateral housing into a massive, solid concrete core at the building center, the CRF expands the housing system into a loose open tube of pressure concrete, surrounding light-filled central atria. Because lateral loads are more broadly distributed, the assembly is more structurally efficient yet less material intensive. Stairs and elevator shafts are now independent of the structure and surrounded by natural light.

Additionally, due to the system’s inherent “plug & play” flexibility, it is intended that the independence of the structural core would allow for programmatic units such as mechanical rooms or elevators to be added or replaced at the discretion of the owner years after the completion of the initial project, thereby allowing the building to be repurposed.

01 Modular Stair Section
02 Modular Wall Panel
03 Shear Wall Diagonal Module
04 Floor System (Shown in atrium Condition)
05 Elevator Module
06 Bathroom Module
07 Atrium Bridge Connection
Putting It All Together

IMPLEMENTATION

Off-site assembly of the ORF will be a fast and exciting grand finale to a process that began, and largely took place, in a controlled factory environment. As modules are assembled to create dynamic spaces, and spaces assembled to form an elegant building, a new and dynamic icon will redefine the Seattle skyline.

The ORF will separate healthy work environments for office inhabitants, responsible use of natural resources, and a secure financial investment for owners. The city will be proud of its new monument to progress. Tenants will readily have space in a building that they know will promote employee productivity and well-being.

BUILDING STRUCTURE

It is expected that the ORF will have a useful life spanning many decades into the future. Careful consideration has been given to ensure its durability and longevity through the testing of potential natural disasters, particularly in a city with significant seismic activity. As the modules of the ORF are lowered into place, they are structurally bonded together by weld pins and NRE shears—a specially designed coupling system that effectively unites the diagonal reinforcing bars from separate posts into a continuous reinforced concrete member.

In the high-rise office tower, lateral loads will be resisted by a "core-only" approach, in which a central diagrid substructure will resist both moment and shear forces. Structural analysis confirms that, through the modules' use of high-strength materials, the structural configuration is more than sufficient to keep tower deflection within acceptable limits. It is anticipated that in the near future, higher-strength concrete and reinforcing steel will become more economical and widely available, therefore using concrete and steel within the assumed materials for the structural testing of the ORF. The core-only structural model of the tower is fully exposed in the building form, by transferring perimeter vertical loads to the core at the bottom of the office base, and allowing the core to stand alone at the bottom third of the office building.
77% reduction

BUILDING ENERGY USE INTENSITY (kBtu/yr/ft²)

- CBEC Average of All Office Buildings: 92.9
- CBEC Regional Office Building Average: 72.0
- CBEC Regional (Mixed Use): 64.5
- ASHRAE [1981-2007]: 44.7
- PROPOSED: 21.5

generated

consumed

100% renewable energy

28,154 MBtus per year

total energy usage
Strategies

ENERGY STRATEGIES

PASSIVE DESIGN STRATEGIES
- Alcoves enhance stack effect
- Sun shades manage summer solar gain
- Thermal mass creates a thermal flywheel effect
- Night air cooling offers thermal mass
- Operable windows provide natural ventilation
- Skylight access reduces artificial lighting

HIGH PERFORMANCE ENVELOPE
- Triple-glazed low-e Arktos filled curtain wall glazing: U-value of 0.8
- Transom: U-value of 0.8
- Insulated curtain wall framing: U-value of 0.8
- Aerodynamically flat aluminum curtain walls
- Continuous insulation avoids thermal breaks
- Low roof: Cost Savings on mass and increases thermal resistance

HIGH EFFICIENCY HEATING & COOLING
- Radiant heating and cooling prevents condensation from ventilation
- Geothermal exchange heating and cooling plant
- High efficiency magnetic heating chillers
- High efficiency heat recovery: heating & cooling plant; option to connect to South Bronx District Energy
- Cooling towers for use of condensing (peak) load only

MIXED-MODE EFFICIENT VENTILATION
- Displacement ventilation with fresh air using floor fans
- Demand-controlled ventilation controls that supply fresh air when CDDs are very high
- Energy recovery ventilators with fully-reheat dehumidification:
  condensation load-air intake with best pre-conditioned air

EFFICIENT LIGHTING
- Daylight reduces need for artificial lighting
- Daylight sensors and dimming: controls provide necessary light in varying light conditions
- Automatic interior outlet shades provide glare control
- Efficient fluorescent/LED fixtures

VERTICAL TRANSPORTATION
- Open stairs increase physical activity of occupants and reduce elevator demand
- Efficient new elevator technology can reduce energy by up to 90%, adding a generation drive that recovers energy flow in braking can save an additional 25%.

OCUPANT BEHAVIOR
- Insulate sub-metering meters and encourages tenant efficiency
- Online building energy management systems provide real-time feedback to encourage better energy usage
- Tenant plug load reductions encourage more efficient equipment
- Task lighting encouraged to reduce general illumination

RENEWABLE ENERGY HARVEST
- Solar hot water (thermal) collection is inexpensive and highly efficient
- Commercial micro-photovoltaic panels with 7% conversion efficiency offer the highest generation per square foot in costs
- A conventional silicon building-integrated photovoltaic system offers the most production in conditions with diffused lighting and vertical surfaces.
Strategies

WATER STRATEGIES

HIGH-EFFICIENCY WATER FIXTURES
- Waterwise-approved basins, showers and toilets ensure quality and reduced consumption.
- Motion-activated and auto shut-off features reduce demand and waste.

RAIN WATER COLLECTION & STORAGE
- Collection from all surfaces, including roofs, green roofs and terraces.
- 25 year-return data confirms good for rainwater harvesting.

EFFICIENT LANDSCAPE IRRIGATION
- Efficient and effective drip irrigation method.
- Drought-resistant landscaping sustains irrigation needs.

MECHANICAL PROCESS WATER COLLECTION & STORAGE
- Reduction of cooling tower flow-down and condenser water flows which can account for 30% of a building's water demand.
- 150,000 cubic foot reservoir captures a large volume of water to vastly reduce demand and waste.

WASTE WATER COLLECTION
- Managing grey water and black water flows together in one user-friendly system.

LIVING MACHINE
- A low-energy system for treating all waste water on site and includes the following:
  - Sedimentation tank for equalising flow and setting solids.
  - Control system to manage flows and ensure performance and quality.
  - Wetland treatment located inside or outside to remove all nutrients and pathogens — this is the visible, odourless portion of the system.
  - Distribution system to carry any remaining pathogens.

REVERSE OSMOSIS PLANT
- For final polishing of Living Machine output as well as collected effluents to produce potable water.

REUSE OF COLLECTED & TREATED WATER
- System meets 80% of potable water needs.
- Elastic reduction in city water and sewer services substantially reduces utility costs.
- Tenants are charged for water services provided by the owner through site-wide water collection and recycling services.
- Payback on systems in as little as 4 years.

Footnotes: