# STRUCTURAL SYSTEM DESCRIPTION

## GENERAL

The proposed new residential building at 108 Center Street will be 7-story with a partial basement. The building will consist of partially framed level one, steel framed levels two and three, and five stories of wood construction over level three (podium).

Design of the proposed building structure will be in accordance with provisions of the 9th Edition Massachusetts State Building Code (MSBC), which amends 2015 International Building Code (IBC 2015).

## FOUNDATION AND GROUND FLOOR

The foundation descriptions are based on "PRELIMINARY GEOTECHNICAL GUIDELINES REPORT" dated February 2020, prepared by Haley & Aldrich.

The foundation system will consist of shallow reinforced concrete footings bearing on either the natural soil. Footings will be designed based on an allowable bearing capacity of 6 kips per square foot. The basement walls will be 16" thick reinforced concrete and will be supported on continuous strip footings. All perimeter footings of the non-basement area will bear a minimum of four feet below grade for frost protection.

The basement floor slab and slab of level one outside basement will be constructed as a 5" thick normal-weight concrete slab reinforced with 6x6-W2.9xW2.9 welded wire fabric and underlain with 15 mil polyolefin vapor barrier, 3 inches of rigid insulation, and 12 inches of crushed stone or compacted structural fill. Because of the low groundwater elevation, no under slab drainage is required; perimeter drainage is recommended at the below grade spaces.

The elevator pit footing will be reinforced concrete of 1'-10" thick supporting 1'- 0" thick concrete walls and lined with crystalline waterproofing at the interior surface.

The level one slab over the basement will be framed with steel beams supporting 3.5" of normal-weight concrete topping poured over 3" deep composite steel deck. Steel beams will be supported by steel plates embedded in the concrete basement walls.

## SUPERSTRUCTURE

The proposed superstructure will consist of 2 stories of steel framed construction supporting 5 stories of wood construction. Floor heights will be 12' level 1 to level 2, 11'-8" from level 2 to level 3, and 10'-8" typical from level 3 to roof. The total height of the building is proposed to be 78'-0" excluding the elevator popups.

<u>Level 2 and Level 3</u>

Level 2 will be steel framed floor consists of W-girders and W-beams supporting 18 gauge, 3" deep composite steel deck with 3.5" of normal-weight concrete topping. Concrete topping will be reinforced with steel welded wire fabric and rebar at slab edges and over girders. Steel beams will be spaced at maximum 10'.

Level 3 will serve as a podium transfer level to support upper wood levels. Level 3 will be constructed of 4.5" of light-weight concrete topping poured over 3" deep composite steel deck. Concrete topping will be reinforced with steel welded wire fabric and rebar at slab edges and over girders. Steel beams will be spaced at maximum 10'. Additional steel beams will be provided to align with wood bearing walls and wood columns bearing on this floor.

Steel girders at both levels will be supported by wide flange steel columns of 12" deep, located at perimeter and along interior corridors and spaced at 20' to 30' on centers.

Lateral loads would be carried by a combination of CMU shear walls and concentric steel braced frames. The CMU walls will be integrated with the elevator and stair cores. The steel braces will be located inside walls to minimize architectural impact.

Wood Framed Upper Floors

Levels 4 through 7 and roof will be wood construction.

***Wall System:*** Unit separation walls and corridor walls will be load bearing. For sound insulation purposes, a unit separation wall will be double-stud walls consists of 2 layers of 4" stud walls sharing 8" common top and bottom plates. Corridor walls will be conventional 6" stud walls. An exterior bearing wall or a load bearing wall within a unit will be conventional 6" stud walls. All walls will include one sheet of 1/2" thick plywood sheathing. All structural wall sheathing shall be lapped between prefabricated panels to ensure proper shear transfer.

***Columns:*** Concentrated loads will be supported by parallel strand lumber (PSL) columns in the walls. These columns will run continuously down to the podium.

***Wall Openings:*** All window and door openings will require a header. For small openings, dimensional lumber will serve as the header. For wider openings, laminated veneer lumber (LVL) headers will be required. Additional studs will be provided at the jambs to support the headers..

***Floor Construction***: Typical floors are supported by a combination of prefabricated wood trusses and performance rated I joists (PRI joists). At typical units, prefabricated wood trusses will be used to span between the unit separation walls. We anticipate 22" deep trusses in typical units. Corridors will use PRI joists spanning between corridor walls. We anticipate typical corridor joist depths to be 9.5" deep. All floor joists will be spaced at 16" OC, 19.2" OC, or 24" OC and topped with ¾" thick plywood sheathing.

***Roof Construction***: The roof of the building will be framed similar to the other upper floors with several exceptions. Extra joists and joist girders will be required at support points with concentrated loads from roof top equipment, PV, roof davits, or roof screens. Roof trusses and joists will also require hurricane ties to resist wing uplift.

***Elevator and Stair Cores:*** The elevator and stair cores for the building will be constructed of 8" thick solid grouted and reinforced concrete masonry unit (CMU) blocks. This wall will also provide bearing for gravity loading and resistance to lateral loading. The wood structure will be anchored to the CMU blocks using a wood ledger with epoxy anchors. These CMU cores will extend through the podium level to connect with the foundation.

***Connection with Podium:*** Typically, the bearing walls and columns align with the steel

beams on the podium to avoid concentrated loading in the concrete deck. At the base of wall studs, columns and sill plates of the wood structure will be anchored into the podium concrete slab with drilled epoxy anchors through metal connectors. Custom metal connectors welded to the steel will be required at wood column locations.

## DESIGN LOADS

The proposed building structure will be designed in accordance with the 9th Edition of Massachusetts State Building Code. The design loads and parameters are as follows:

**Floor Live Loads:**

1. Public Area, Stairs and Corridors: …….…….. 100 PSF
2. Dwelling Units: ……..……..... 40 PSF
3. Offices…….. ……..……50 PSF
4. Storage or Mechanical Room ……..……150 PSF

**Dead Loads:**

1. Mechanical Units: …….....…..... Actual Weights
2. Roofing and Insulation…….……..……..... 5 PSF
3. PV Panels and Ballast …….……..……..... 20 PSF
4. Services and Ceiling …….……..……...….. 10 PSF
5. Structure …….……..…….....…Estimated Actual Weights

**Roof Snow Loads:**

1. Ground Snow Load Pg = 40 PSF
2. Snow Load Pf = 30 PSF + DRIFT

**Wind Loads:**

1. Basic Wind Speed = 128 mph for risk category 2
2. Exposure: B

**Earthquake Loads:**

1. Seismic Importance Factor, I=1.25
2. Mapped Spectral Response Acceleration at Short Period: $S_s$ = 0.211g
3. Mapped Spectral Response Acceleration at 1 second: $S_1$ = 0.068g
4. Site Class: D (assumed)
5. Seismic Design Category B
6. Lateral Load Resisting System: Braced steel frame below Level 3, Wood and Reinforced CMU block shear walls above 1st floor.
7. Response Modification Factor: R = 3
8. Analysis Procedure: Equivalent Lateral Force Analysis

# STRUCTURAL OUTLINE SPECIFICATIONS

## WOOD CONSTRUCTION

1. General Structural Wood
   - Lumber is to be kiln dried and have a moisture content of not more than 19 percent.
   - All structural wood shall have the following minimum design values and shall have material certificates and grades stamps attesting therof (units in PSI unless noted otherwise).

| | Fb | Ft | Fv | Fc Parallel | Fc Perpendicular | E (ksi) |
|---|---|---|---|---|---|---|
| Sill/bottom Plates and Top Plates (SYP #2) | 1100 | 675 | 175 | 1450 | 565 | 1400 |
| Studs, Built up Columns, Blocking (SPF #2) | 875 | 450 | 135 | 1150 | 425 | 1400 |
| All other Conventional Wood (SPF #2) | 875 | 450 | 135 | 1150 | 425 | 1400 |
| Parallel Strand Lumber | 2900 | 2025 | 290 | 2900 | 750 | 2000 |
| Laminated Veneer Lumber | 3100 | 2150 | 285 | 3000 | 750 | 2000 |

2. Prefabricated Wood Trusses
   - All wood floor and roof trusses shall conform to the latest edition of “National Design Specification for wood construction” and “Design specification for metal plate connected wood truss” truss plate institute.
   - Truss manufacturer shall provide calculations for all the roof trusses to account for snow drift and dead loads for roof locations with crickets, gusset and valleys. Provide additional roof framing for intersection of higher or lower roofs in accordance with ASCE 7-10.

3. Performance Rated I Joists
   - All wood floor and roof trusses shall conform to the latest edition of “APA PRI-400”. Trusses shall have structural capacities in compliance with ASTM D5055.
   - I joist manufacturer shall provide calculations for all the joists to account for snow drift and dead loads for roof locations with crickets, gusset and valleys. Provide additional roof framing for intersection of higher or lower roofs in accordance with ASCE 7-10.

## MASONRY CONSTRUCTION

- Masonry construction shall conform to Building Code Requirements for Masonry Structures (ACI530-11)
- CMU strength shall have a minimum compressive strength of f’m = 2,500 psi
- CMU shall confirm to ASTM C90, Type I, Grade N, medium weight.
- Mortar shall conform to ASTM C270 Type S. 1 part cement, ½ lime, 4 ½ sand (ASTM

C270)
- Grout shall conform to ASTM C-476 with minimum f'c=3,000 psi
- Minimum masonry reinforcement shall be at least #6 bar at 16" OC vertically in solid grouted cores.

## CONCRETE CONSTRUCTION

1. Concrete
   - All concrete will be normal weight except for concrete on framed slabs, which will be light weight concrete.
   - 28 day compressive strength will be 4,000 psi for both normal weight concrete and light weight concrete.
   - Portland Cement: ASTM C150, Type I or Type II.
   - Aggregate: normal weight and light weight, ASTM C33.
   - Fly Ash: ASTM C618, Class F. Cement replacement with fly ash is limited to 20% in weight.
   - Air-entraining Admixture: ASTM C260.
   - Water-reducing Admixture: Optional, ASTM C494, Type A, containing not more than 0.1% chloride ions.
   - Accelerator, Water-reducing Admixture: ASTM C494, Type E, containing not more than 0.1% chloride ions.
   - Retarder, Water-reducing Admixture: ASTM C494, Type D, containing not more than 0.1% chloride ions.
   - Superplasticizer: High-range water reducer conforming to ASTM C494, Type F or Type G.
2. Reinforcing Materials:
   - Reinforcing Bars: ASTM A615 including S1, Grade 60, Deformed.
   - Welded Wire Fabric: ASTM A185.
3. Accessories:
   - Supports for reinforcement shall be bolsters, chairs, spacers, and other devices that comply with CRSI standards.
   - Ties: Black iron, plastic straps, or stainless steel. Supports and ties shall be non-staining where used within 3 inches of surfaces that will be exposed in the finished structure or where weathering during construction may stain exposed surfaces.

## STRUCTURAL STEEL

Steel Components shall conform to requirements of the AISC. Materials shall meet the following specifications and standards:

- Structural Steel – W-Shapes ASTM A992 (Fy = 50ksi to 65 ksi)
- Structural Steel – Shapes other than W-Shapes, Plates and Bars: ASTM A572, Grade 50 (Fy = 50 ksi) .
- Structural Steel - Column Base Plates: ASTM A36 (Fy = 36 ksi).
- Structural Tubing (HSS Section): ASTM A500, Grade B.
- Steel Pipe: ASTM A501 or ASTM A53, Types E or S.
- Anchor Rods: ASTM F1554, 3/4" diameter or larger, Grade 36 or 55.
- High Strength Bolts: ASTM A325, type N and slip-critical.
- Filler Metal for Welding: E70XX low hydrogen
- Shear Connectors: Headed studs conforming to ASTM A108, Grades 1015-1020, 3/4" diameter, minimum yield point of 50,000 psi, and minimum tensile strength of

60,000 psi.

- Primer Paint: Provide primer paint specified and scheduled in Section 09900.
- Galvanizing: Hot dipped galvanize (2 oz. per square foot of surface) designated steel after fabrication in compliance with ASTM A123. Galvanizing shall be confirmed using Preece Test Method per ASTM A239. All steel exposed to weather, including relieving angles, shall be hot dip galvanized.

**STEEL DECK**

Composite steel deck at second floor shall conform to requirements of the Steel Deck Institute. Materials shall meet the following specifications and standards:

- Composite Steel Floor Deck shall be 3" deep and 18 gage thick, and shall conform to ASTM A653, Grade 33 or higher, with a minimum yield strength of 33,000 psi; Galvanized Coating: Shall conform to ASTM A653, coating class G60.
- Deck Accessories: Fabricate deck accessories of 18 gage minimum sheet steel, with galvanized coating. Provide following typical accessories and any additional accessories required by deck manufacturer's steel deck system: cell closures for ends of steel deck at columns, walls, openings, perimeter conditions, and where deck changes direction, drain pans or sumps.
- Rust-inhibiting priming paint for touch-up: "Tnemec-Zinc 92" by Tnemec Co.; "Rust-Oleum 7085" by Rust-Oleum Co.; or "Aquapon UC-40059" by P.P.G. Industries.
- Welding Materials: Conform to AWS Code and AWS filler metal specifications.