500 FOLSOM
TRANSBAY BLOCK 9

KEY PARAMETERS

Tower
Height: 400 ft
Floors: 43

Podium
Height: 85 ft
Floors: 8

Basement
Depth: -76 ft (b/mat)
Floors: 6

Gross Area: 700,000 sqft
TOWER PLAN
TYPICAL – 12 UNITS

KEY PARAMETERS

DENSE UNIT CONFIGURATIONS

Units
  All columns at demising walls
  Heat pumps at partitions

Central Core
  Clear central core configuration
  Coordinated with all MEP trades in schematic design

Framing
  Units coordinated with PT layout
  Repetitive edge of slab
PROJECT OVERVIEW

Slender Tower

- **545 TOTAL UNITS, INCLUDING 3 TOWNHOUSES** ON CLEMENTINA
  - **436 MARKET RATE UNITS**
  - **109 AFFORDABLE UNITS (20% OF TOTAL)**

Large Podium

OPEN SPACE

- **9,330 SQ FT** AT L9 LANDSCAPED TERRACE
- **2,915 SQ FT** AT GROUND LEVEL

FOLSOM BOULEVARD RETAIL

- **6,775 SQ FT** GROUND LEVEL RETAIL

Very deep basement

- **-76 ft to bottom of mat**

No piles.

Mat + ground improvements

BELOW GRADE PARKING (6 LEVELS)

- BIKE PARKING AT B1: **206 (.38:1)**
- APROX 286 STALLS (.52:1) FROM B1 TO B6 COMPRISED OF:
  - **269 SELF PARK**
  - **11 HC**
  - **3 CAR SHARE STALLS**
  - **3 CHARGING STATIONS**

500 FOLSOM – BEYOND VERIFICATION | TOWARDS DESIGN
SKIDMORE, OWINGS & MERRILL LLP / LAGAN
GEOTECHNICAL DATA

BORING LAYOUT
SITE SOIL PROFILE

ROCK/CLAY

SAND (SP), CLAYEY SAND (SC), SANDY CLAY (CL), CLAY with SAND and GRAVEL (CL), CLAY (CL-CH), loose, medium stiff to very stiff [PILL], SAND (SP), very loose to medium dense [DUNE SAND]

SAND (SP), SAND with SILT (SP-SM), SAND with CLAY (SP-SC), SILTY SAND (SM), CLAYEY SAND (SC), medium dense to very dense [COLMA FORMATION]

SAND (SP), CLAYEY SAND (SC), CLAY (CH), CLAY (CL), SILTY CLAY (CL-CH), medium dense, soft to stiff [MARSH DEPOSITS]

SAND (SP), SAND with SILT (SP-SM), SAND with CLAY (SP-SC), SILTY SAND (SM), CLAYEY SAND with GRAVEL (SC), SANDY CLAY (CL), CLAY with SAND and GRAVEL (CL), CLAY (CL), dense to very dense, very stiff to hard [Interbedded SANDS and CLAYS]

Projected 15° Southwest
Projected 5° Northwest
Depth at 156.3'

Projected 3° Northwest
Projected 20° Southeast
Projected 20° Southeast
Projected 15° Southwest
Projected 10° Southwest

Bedrock SHEARED SHALE and SANDSTONE, crushed to closely fractured, low hardness to moderately hard, friable to moderately strong, with isolated shearing, clay infilling, and quartz veins [FRANCISCAN COMPLEX MELANGE]

Proposed bottom of excavation

Existing Ground Surface

Elevation: ~30.7 feet
Elevation: ~25.7 feet

ELEVATION (Feet, NAVD 88)

Revealed layers of soil and rock profile at 500 Folsom – Beyond Verification | Towards Design

SKIDMORE, OWINGS & MERRILL LLP / LANGAN
SITE SOIL PROFILE

ROCK/CLAY

SAND (SP), CLAYEY SAND (SC), SAND with CLAY (CL), CLAY with SAND and GRAVEL (CL), CLAY (CL), CLOTHOID SLOPE, MEDIUM STIFF TO VERY DENSE [FILL]

SAND (SP), SAND with SILT (SP-SM), SAND with CLAY (SP-SC), SILTY SAND (SILT), CLAYEY SAND (SC), MEDIUM DENSE TO VERY DENSE [CALMA FORMATION]

SAND (SP), CLAYEY SAND (SC), CLAY (CL), SILTY CLAY (CL-CH), MEDIUM DENSE TO STIFF [MARSH DEPOSITS]

SAND (SP), SAND with SILT (SP-SM), SAND with CLAY (SP-SC), SILTY SAND (SILT), CLAYEY SAND with GRAVEL (SC), SANDY CLAY (CL), CLAY WITH SAND and GRAVEL (CL), CLAY (CL), DENSE TO VERY DENSE, VERY STIFF TO HARD [INTERBEDDED SANDS AND CLAYS]

BEDROCK SHEAR SHALE and SANDSTONE, CRUSHED TO CLOSELY FRACURED, LOW HARDNESS TO MODERATELY HARD, FRIABLE TO MODERATELY STRONG, WITH ISOLATED SHEARING, CLAY INFILLING, AND QUARTZ VINES [FRANCISCAN COMPLEX MELANGE]
JET GROUT COLUMNS

EXTENSIVE GROUND IMPROVEMENTS
SPECTRA DEVELOPMENT - CMS

PER DRAFT OF ASCE 7-16
GROUND MOTIONS

CMS-LONG PERIOD (5.5 SEC)
INTERACTION BETWEEN SEOR AND GEOR – SIMPLIFIED SSI
BEARING PRESSURES, MAT RIGIDITY, AND ESTIMATED SETTLEMENTS
SOIL STIFFNESS
COMPLEX BEHAVIOR

Soil stiffness varies from rock (left) to improved soils (right).

Significant change under core.
TOWER PLAN
SCHEMATIC DESIGN

Core Aspect Ratio: 14 : 1

Outriggers

29 ft
29 ft
400 ft
400 ft
Core Aspect Ratio: 12 : 1

SRC Coupling Beam

33 ft
**KEY PARAMETERS**

**Slabs**
- Avg span: 28 ft
- Thickness: 7 in
- Strength: 6,000 psi

**Shear Walls**
- Thickness: 30” – 24”
- Strength: 8,000 psi

**Coupling Beams**
- Depth: 22”, 18”
- Diagonally reinforced

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**Core Aspect Ratio**: 12 : 1
TOWER CORE
ELEVATIONS
DESIGN SUMMARY
BUILDING CHARACTERISTICS

Modal Summary

Decoupled modes between translation and torsion

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DESIGN SUMMARY

LINEAR CODE-BASED DESIGN

Design Level Earthquake (DE)

ETABS model w/site-specific response spectrum loading

Drift and global code checks satisfied

All components satisfy code prescribed strength checks – shear walls, coupling beams, gravity columns, etc

Service and MCE Level Earthquake (SLE & MCE_R)

ETABS model w/site-specific response spectrum loading

Drift and global code checks satisfied (0.5% & 3%)

All components satisfy code prescribed strength checks based on design criteria
NONLINEAR MODELING

KEY COMPONENTS

Coupling Beam Modeling: w/RC Slab

Wall Fiber Arrangement

Deformation Gages
GROUND MOTIONS

CMS-LONG PERIOD (5.5 SEC)
GROUND MOTIONS

CMS-SHORT PERIOD (1.3-2.5 SEC)

ROTATION RESPONSE SPECTRUM, SHORT PERIOD

PSa (g)

Period (sec)
DESIGN CHANGES
BASED ON NLRHA

- Increase boundary vertical reinforcing to reduce yielding.
- Increased link beam diagonal reinforcement to reduce rotations.
- Mitigated strength loss of link beams reduced wall strain.
- Increased link beam span to reduce rotation (comparative results not shown).
- Reduced boundary vertical reinforcing to encourage hinge at top of podium.
STRAIN DEMANDS

CONFINEMENT DISTRIBUTION BASED ON NLRHA

(a) Wall with $h_0/t_w \geq 2.0$ and a single critical section controlled by flexure and axial load designed using 18.10.6.2, 18.10.6.4, and 18.10.6.5

(b) Wall and wall pier designed using 18.10.6.3, 18.10.6.4, and 18.10.6.5

Fig. R18.10.6.4.2—Summary of boundary element requirements for special walls.

Notes: Requirement for special boundary element is triggered if maximum extreme fiber compressive stress $\sigma = 0.2\sigma_y$. Once triggered, the special boundary element extends until $\sigma < 0.15\sigma_y$. Since $h_0/t_w \leq 2.0$, 18.10.6.4(c) does not apply.

Compressive Strain Limits
- Unconfined Limit = $0.003/2'*1.5'' = 0.001$
- Ordinary Limit = $0.004/2' = 0.002$
- Special Limit = $0.013/2'' = 0.006$

*Reduction in limit by 2 per Wallace, 2007
**Reduction in limit by 1.5 due to force-controlled action

Tensile Strain Limits
- Unrestrained bar limit = 1x yield
- 8" spacing bar restraint = 2x yield
- 6" spacing bar restraint = 10x yield
Strain Demands
Applied to Core

Baseline SP Tensile Strains
- $\varepsilon \leq 1x$ yield
- $1x$ yield $< \varepsilon \leq 2x$ yield
- $2x$ yield $< \varepsilon$
- Non-boundary $1x$ yield $< \varepsilon \leq 2x$ yield
- Non-boundary $2x$ yield $< \varepsilon$

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STRAIN DEMANDS
APPLIED TO CORE

Panel Ties

Ordinary BZ 6"

Typ

Special BZ

Ordinary BZ 6"

Typ

Level 13

Level B2
REINFORCEMENT COMPARISON

Original design using RS analysis

Reinforcement design using NLTH results

(~ 500’000 $)
BEYOND VERIFICATION AND TOWARDS THE DESIGN OF SLENDER CORE-ONLY STRUCTURES USING PBSD

11NCEE – LA 2018

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