MILLENNIUM TOWER

PERIMETER PILE UPGRADE

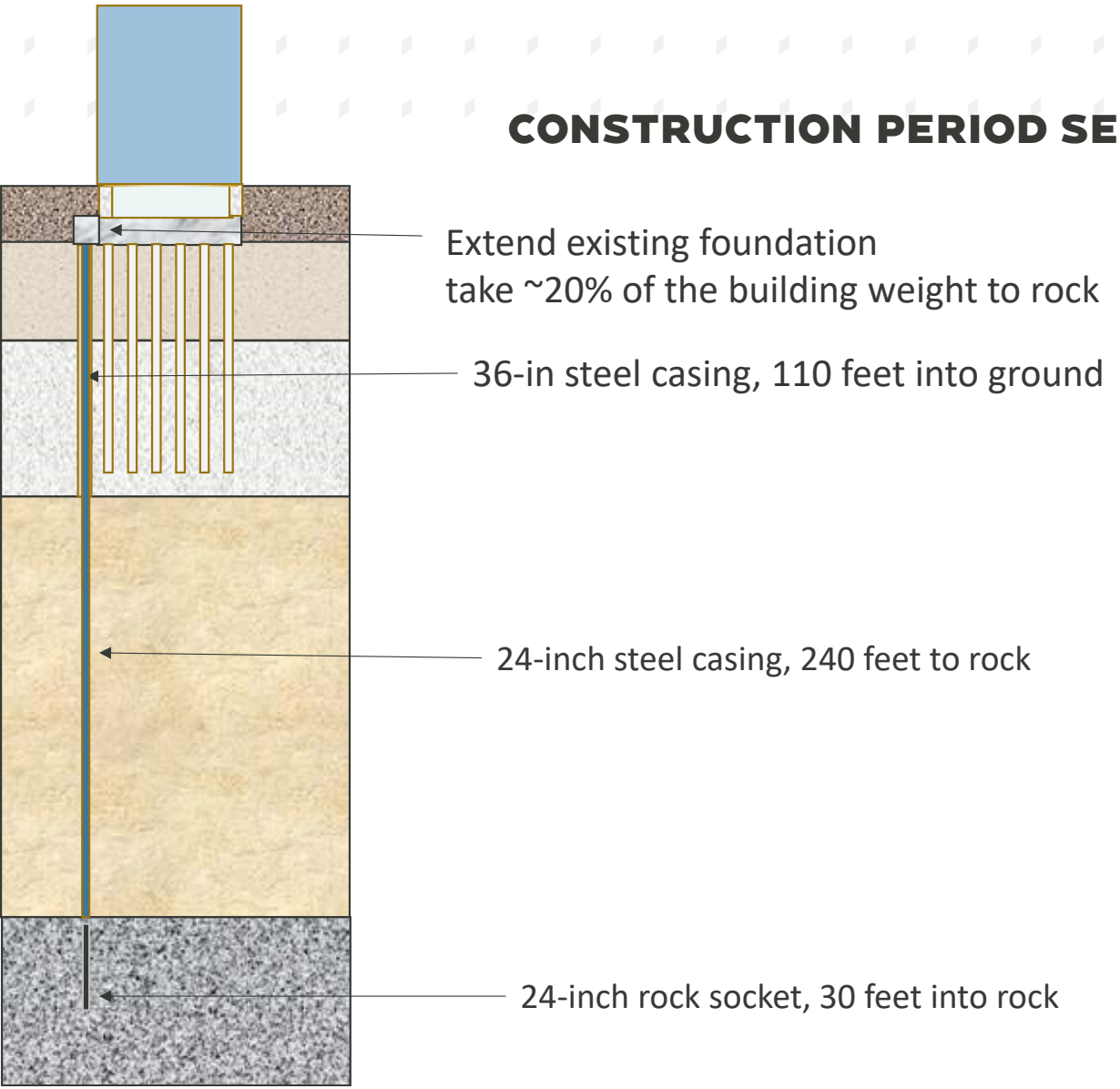
RO Hamburger, SE

THE PROBLEM AND THE SOLUTION

SGH

- Under the building's weight, and the effects of dewatering, Old Bay Clay soil at depth is consolidating (water is squeezed out by the pressure)
- Tilting occurs because the soil beneath the building is not uniform and deep basements on buildings to the east and west result in less weight on those sides
- The goal of the voluntary upgrade is to arrest further settlement (once construction is complete) and allow gradual recovery of tilt
- Accomplished by:
  - installing new piles to rock on north and west sides
  - jacking load off the existing foundation and onto the new piles

CONSTRUCTION PERIOD SETTLEMENT AND TILT



- Settlement and tiling occurring during construction due to:
  - Over-excavation of soil
  - Vibration – related densification of soils
- Preliminary testing of modified installation procedures indicates these effects can be acceptably controlled

BUILDING SETTLEMENT HISTORY

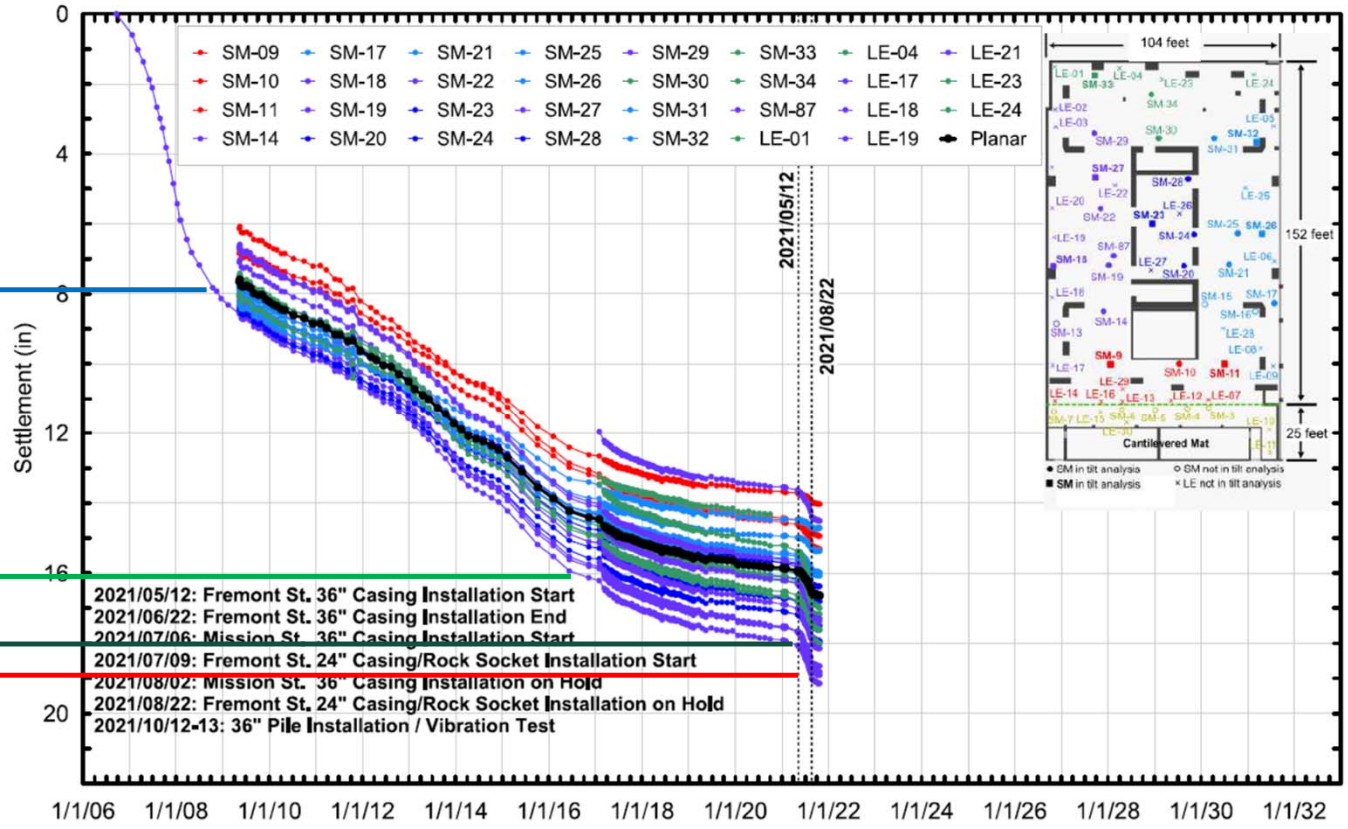
2009 - Construction completes – 8”

2018 - Dewatering completes – 16”

11/20 – Upgrade starts– 18”

08/21 – Moratorium– 19.3”

Today – 19.5”



BUILDING TILT HISTORY

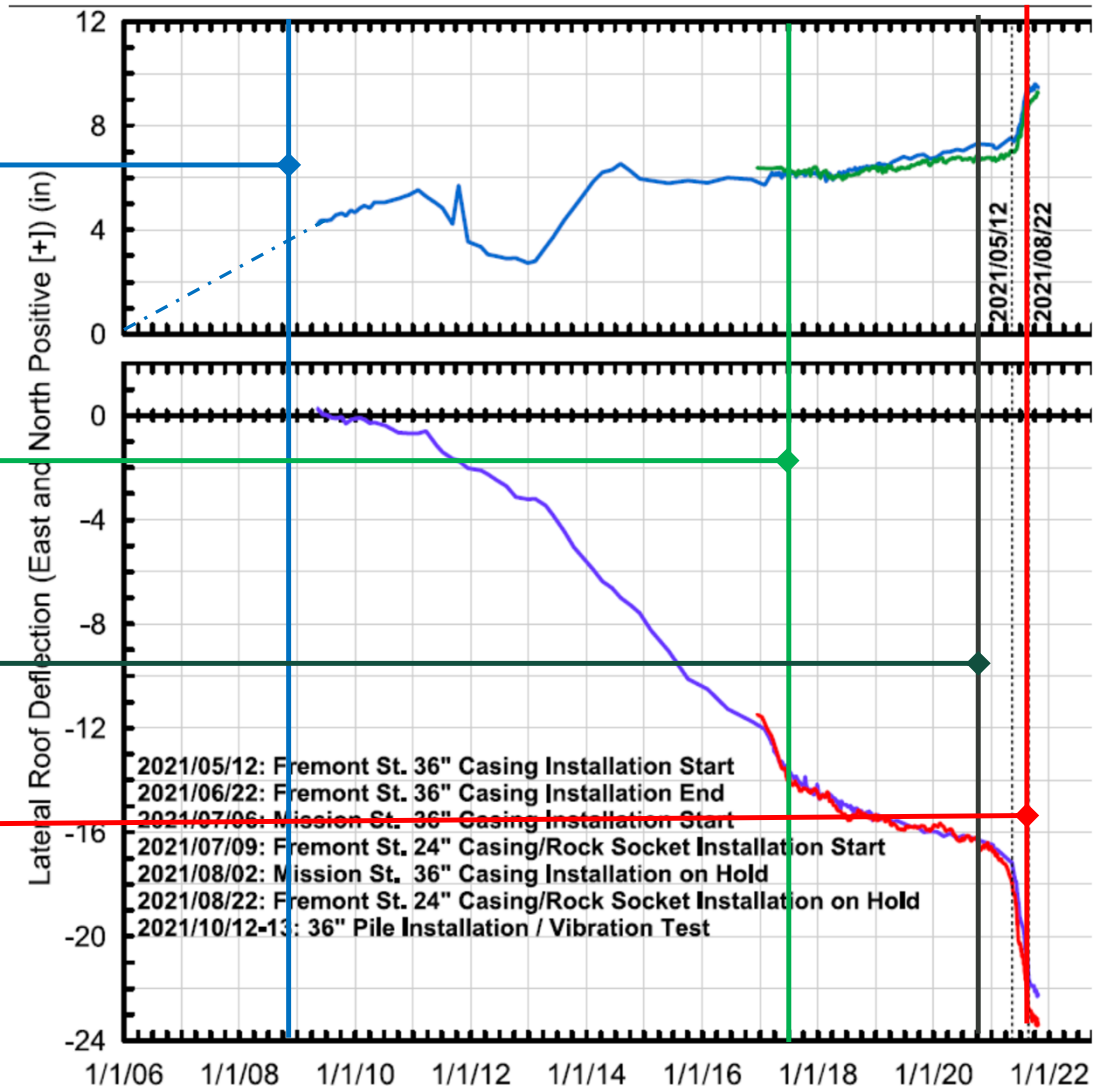
2009 - Construction completes – 4” N 0” W

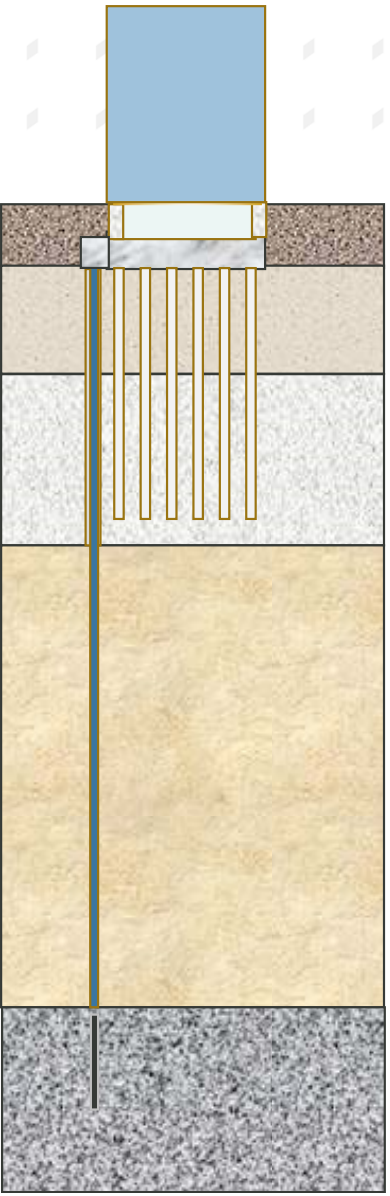
2018 - Dewatering completes – 6” N 14” W

11/20 – Upgrade starts– 7” N 17”W

08/21 – Moratorium– 9”N 23” W

Today – 9.5” N 23.5” W





CONSTRUCTION MITIGATION OF SETTLEMENT / TILT

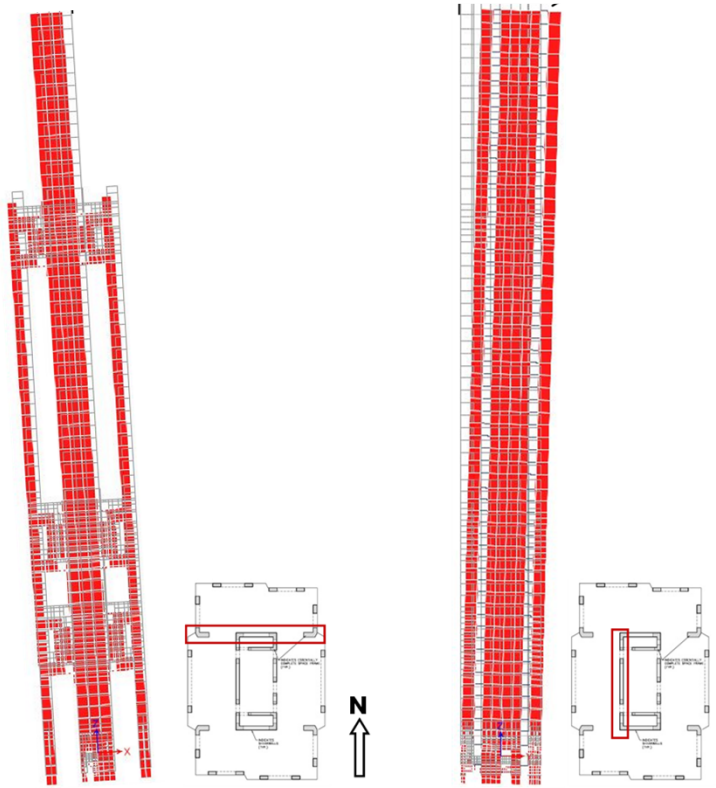
- 36-inch Casings
  - Cut casings free of “guide walls” to minimize vibration
  - Maintain water level in casing during installation, to prevent “blowouts”
  - Maintain plug depth at casing base to prevent heave
  - Avoid stopping casings with tip near existing pile depth
- Successful test demonstrated these measures are effective

- 24-inch Piles
  - Isolation of casings from guide walls
  - Smaller diameter drill bit
  - Control of advancement speed, water and air pressure

- Test planned for November 15

HOW MUCH TILT CAN THE BUILDING TOLERATE?

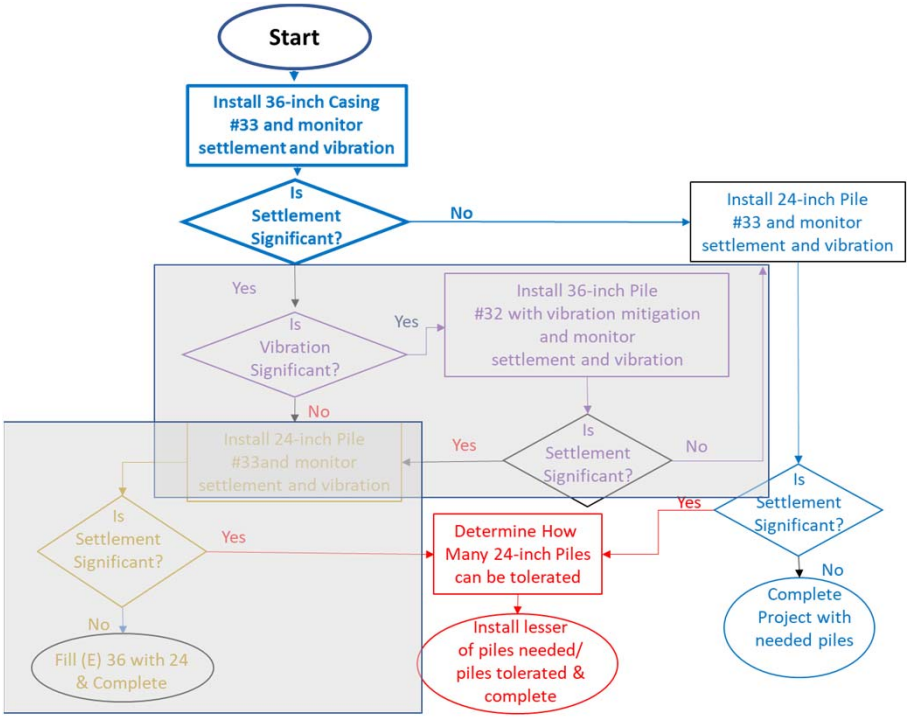
- In 2018, SGH demonstrated with EDRT review that building could safely sustain twice the 2018 tilt
  (12” N, 28”W)
- Recently we evaluated building for three times present tilt and found it safe
  (EDRT review pending)
  (33”N, 79”W)
- Safety includes under building’s own weight in combination with a repeat of a code-maximum earthquake (worse than 1906)
- From a practical perspective we will consider tilt up to 40” as an acceptable limit, based on present design criteria for tall buildings



Simulation of foundation tilt
in analytical model

PLAN GOING FORWARD

- Test 36- inch casing
- Test 24-inch casing
- Install maximum number of piles that can be tolerated using improved procedures
- Complete project



SCHEDULE

- The original project schedule had a 22-month duration
- Construction initiated in November 2020
  - Construction halted in August 2021
  - Assuming construction restarts in December 2021 it can be completed in December 2022.
- Success =
  - A completed project
  - Settlement has stopped
  - Tilting gradual recovers over time