

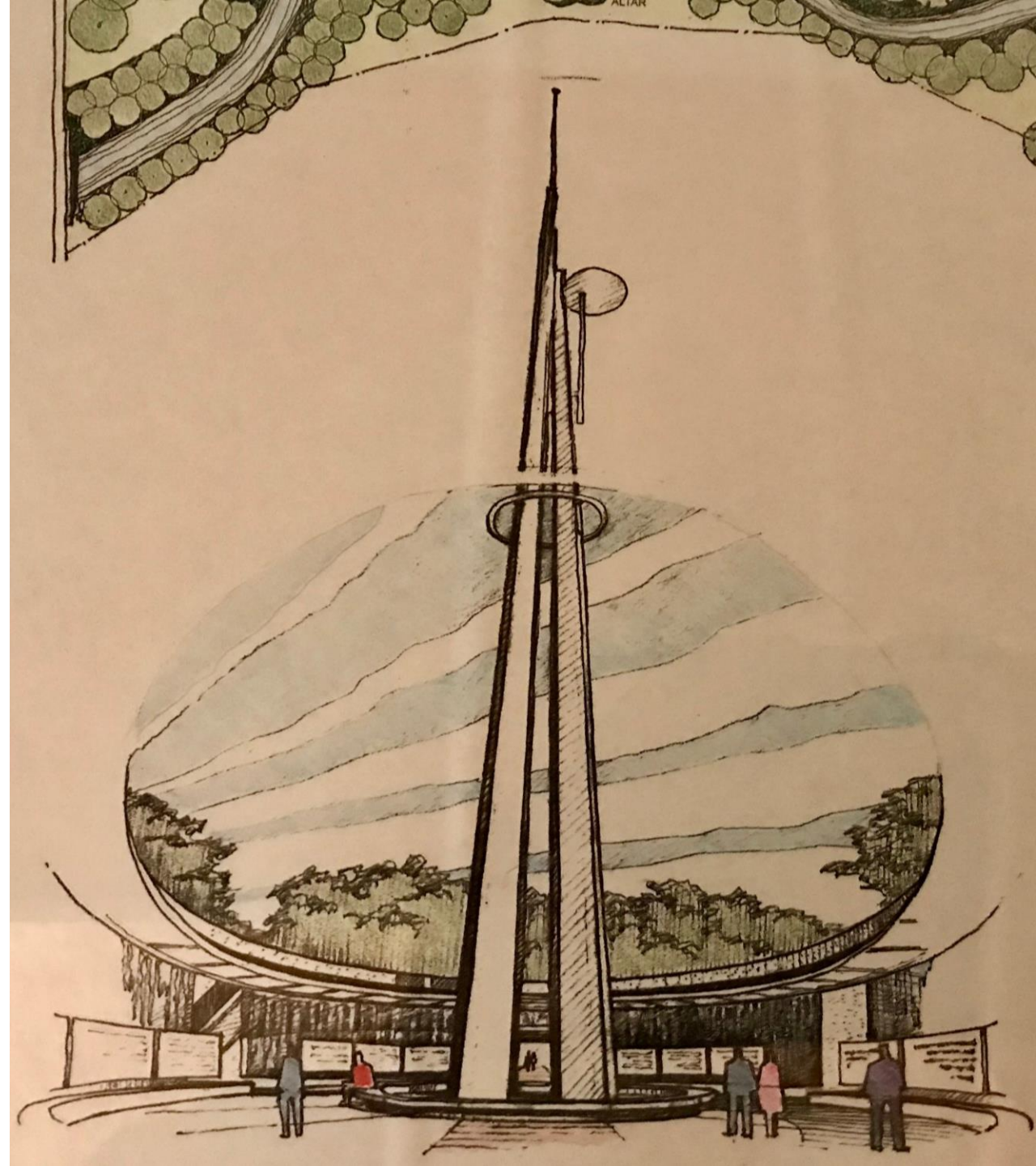
TRADE SECRET

Dr. Martin Luther King, Jr. Memorial

Spire Structure

Arup

March 3, 2021

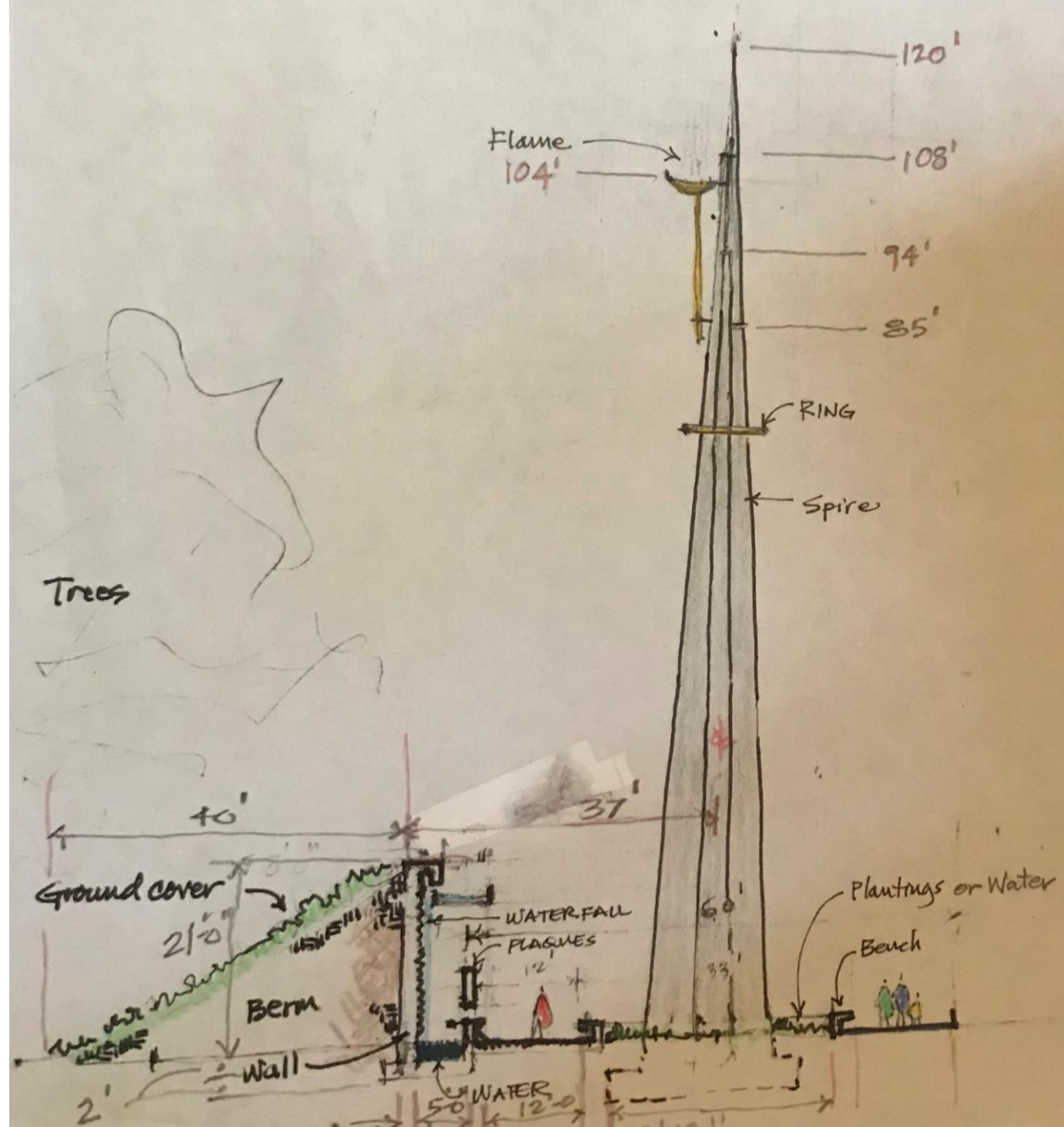




Site Plan – Fayetteville, NC

Spire Geometry

- 4 steel pylons arranged in cruciform shape at base, tapered to various heights
- 22 ft x 18 ft plan profile
- 120 – 136 ft tall
- Flame torch at 104 ft



Design Criteria

Codes

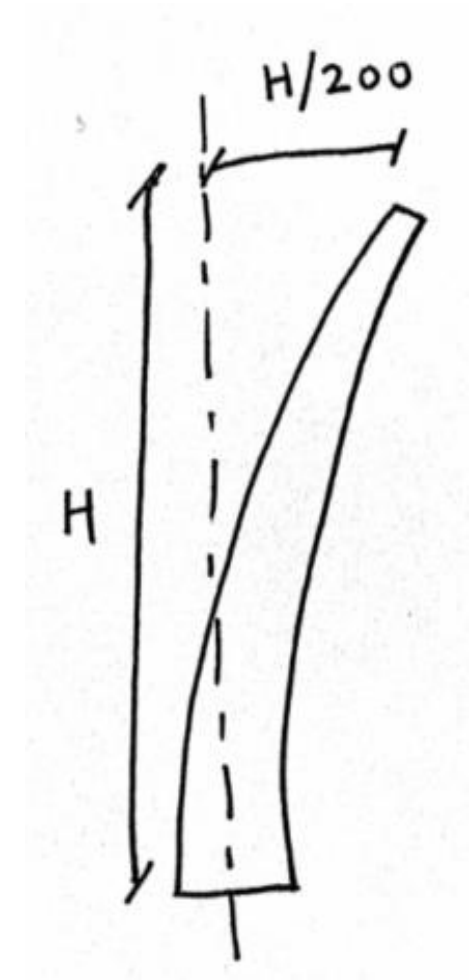
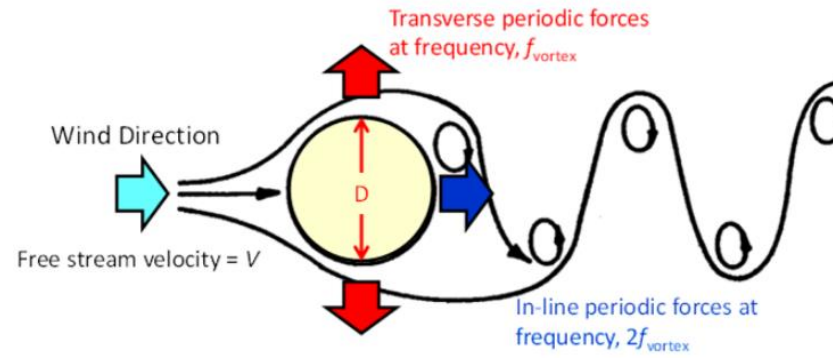
- North Carolina Building Code
- ASCE 7-16

Loading on structure

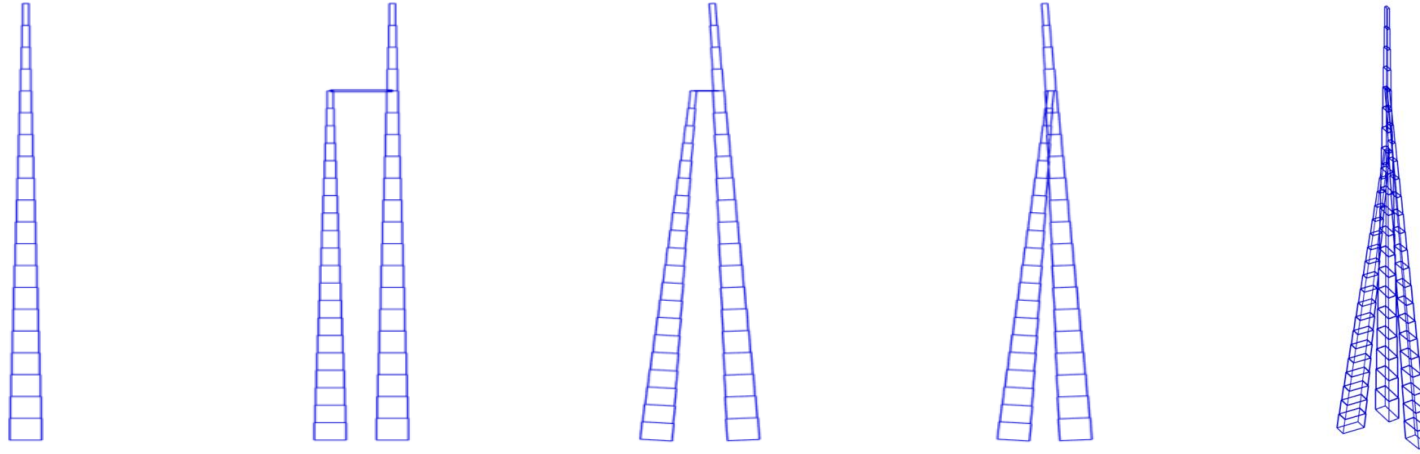
- Dead load (self weight of structure)
- Wind loads
 - Basic wind speed of 121 mph
 - Tornado wind speed 200 mph
- Snow loads (10 psf)
- Ice loads (1.5 in. thick ice)

Lateral Deflections

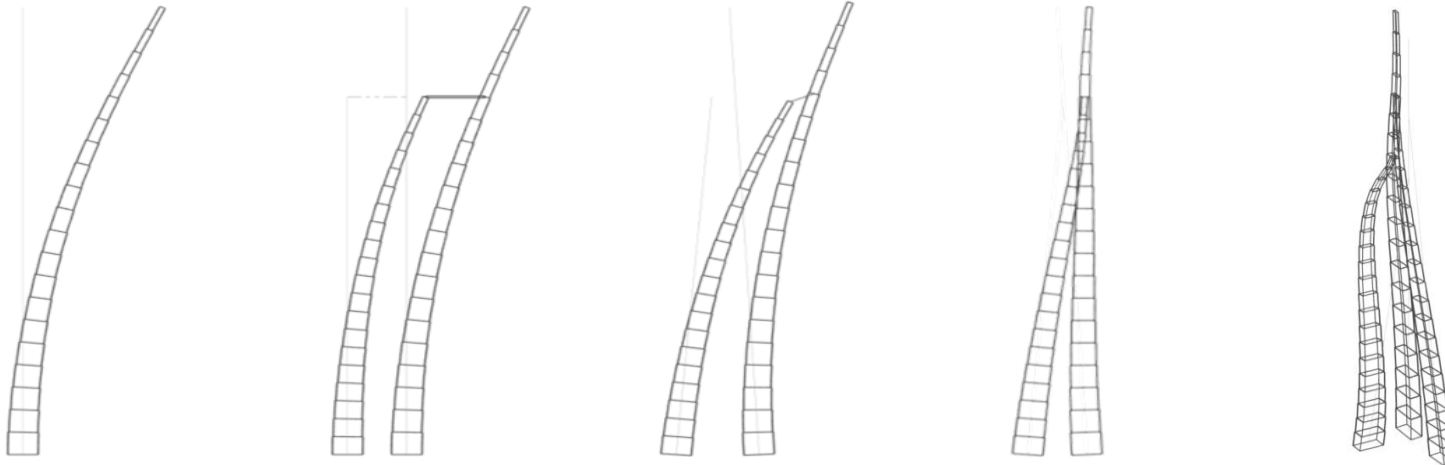
- Limit to Height/200 under wind loads (approx. 8")



Interaction between Pylons

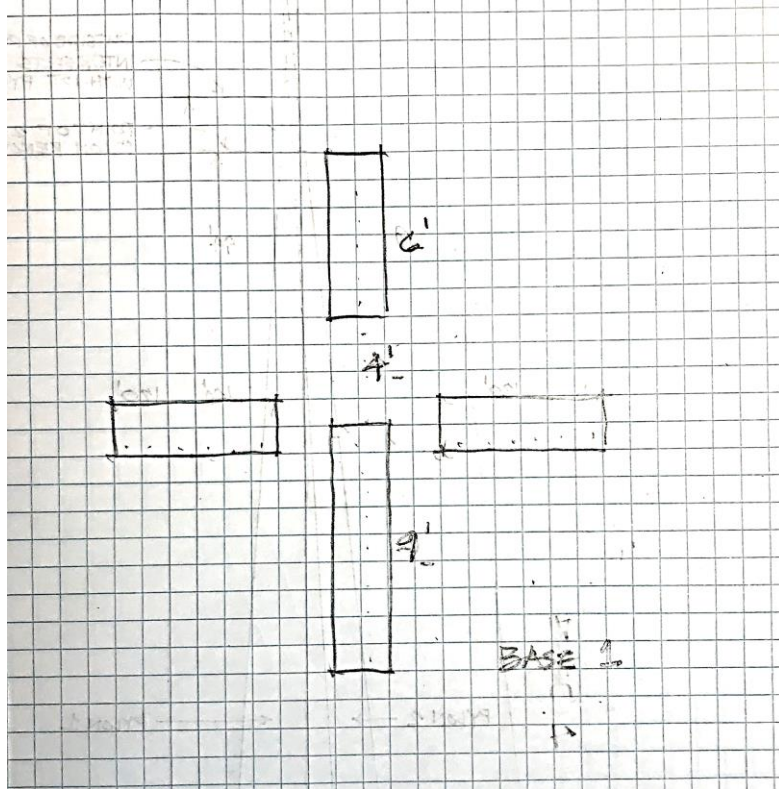


Test Models

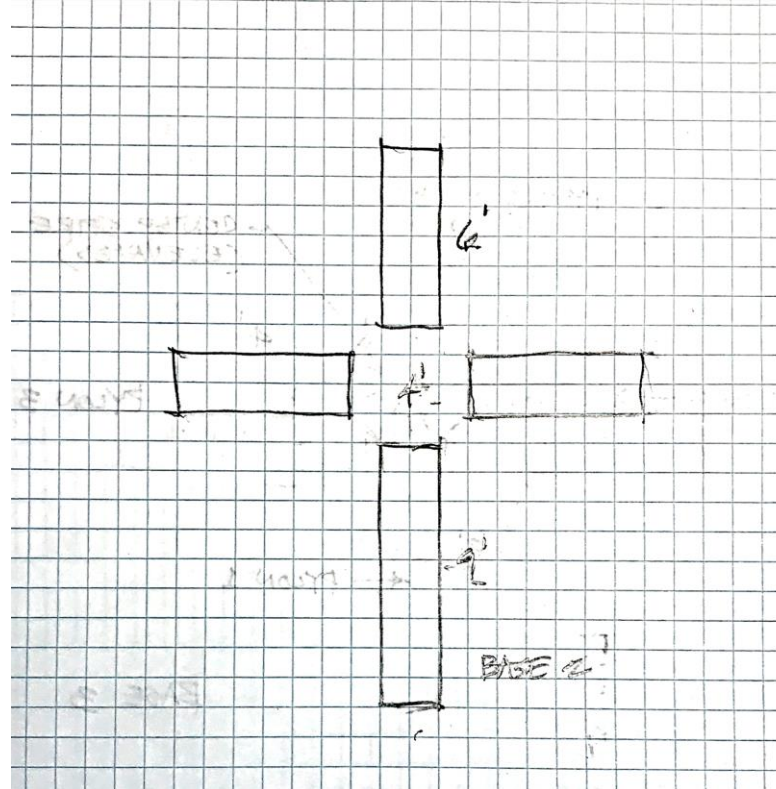


Response to Wind Loads

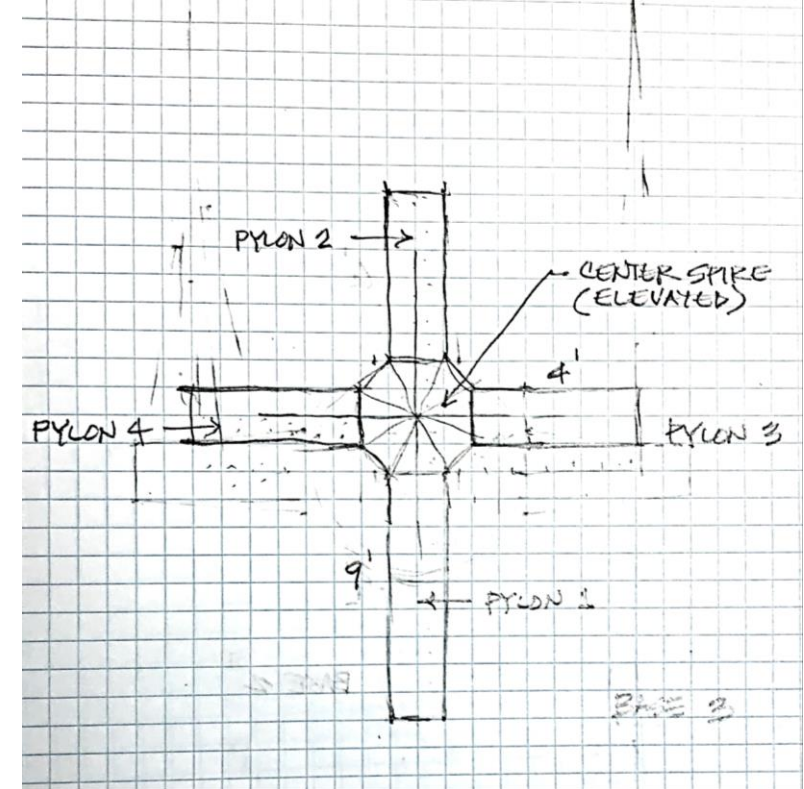
Base Scheme Options



Scheme 1

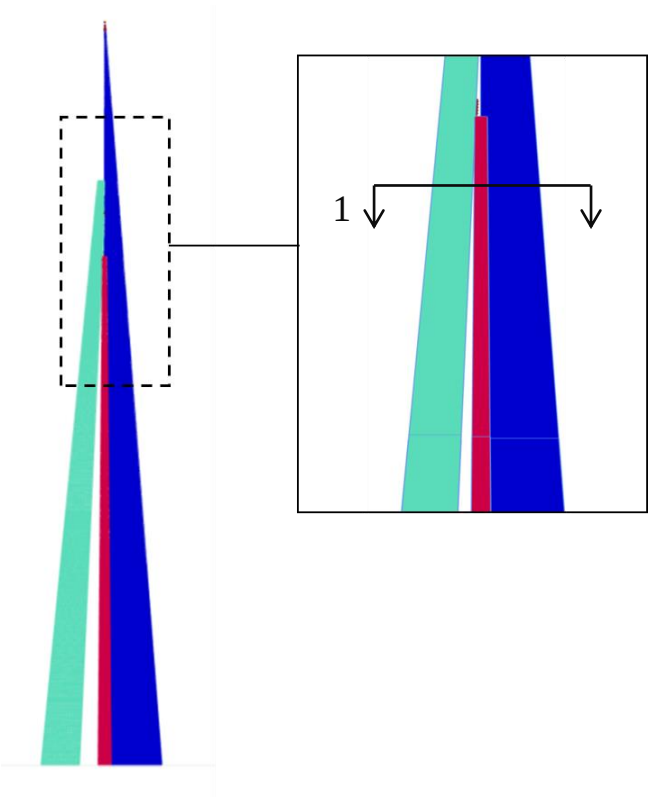


Scheme 2

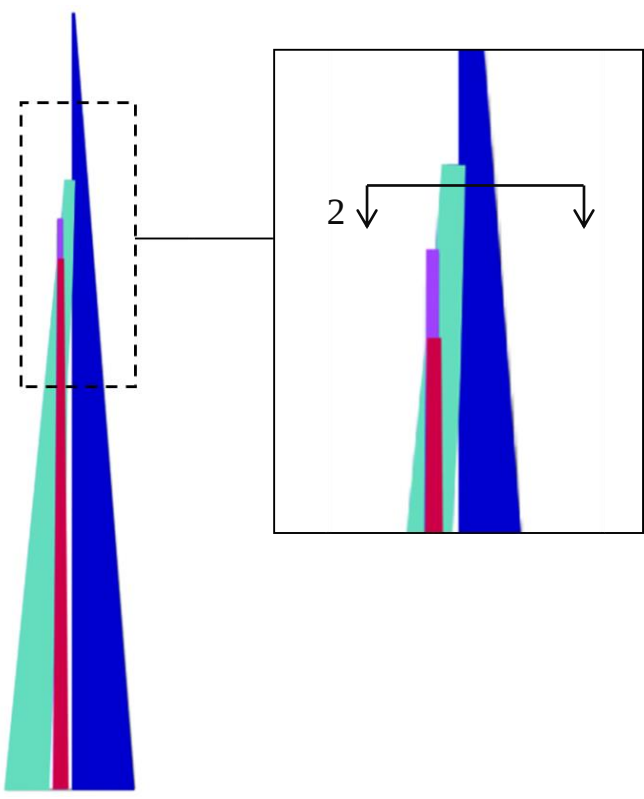


Scheme 3

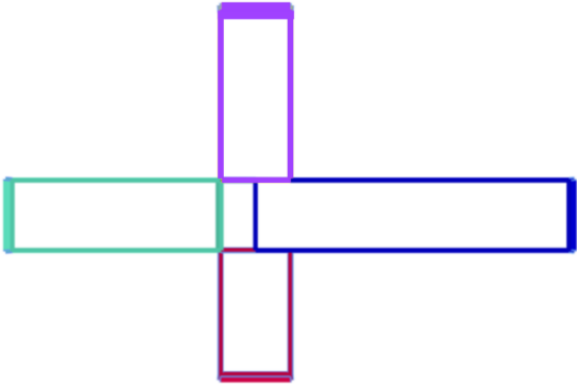
Intersection Geometry



Scheme 1



Scheme 2

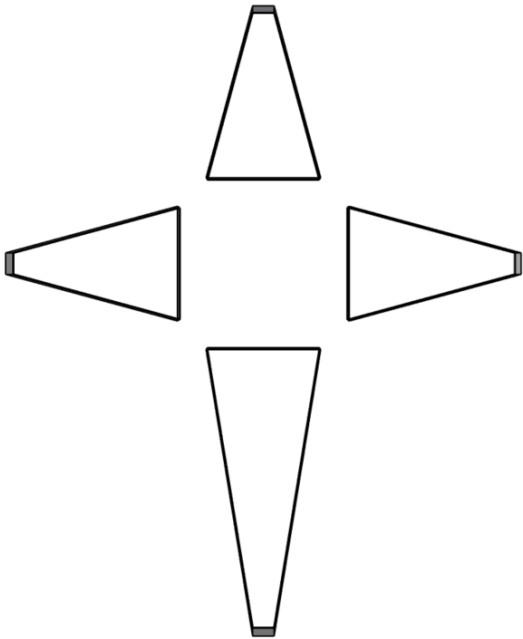
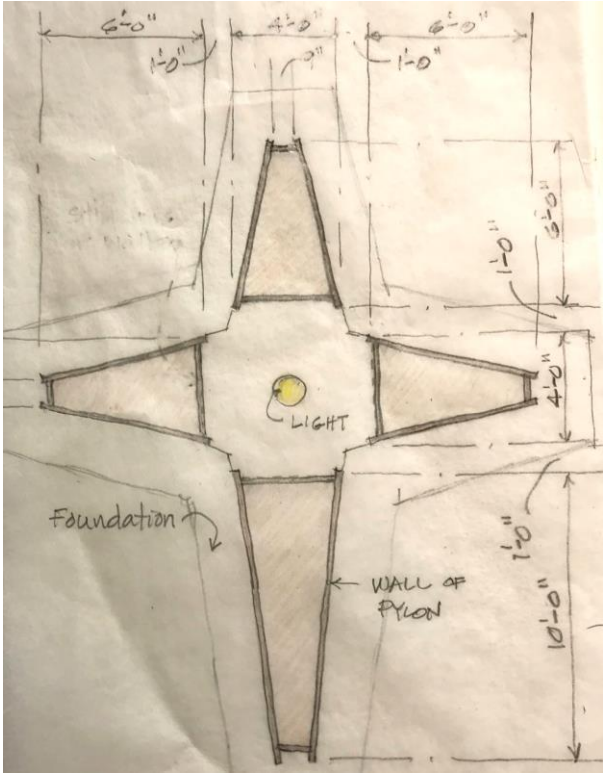


Section 1

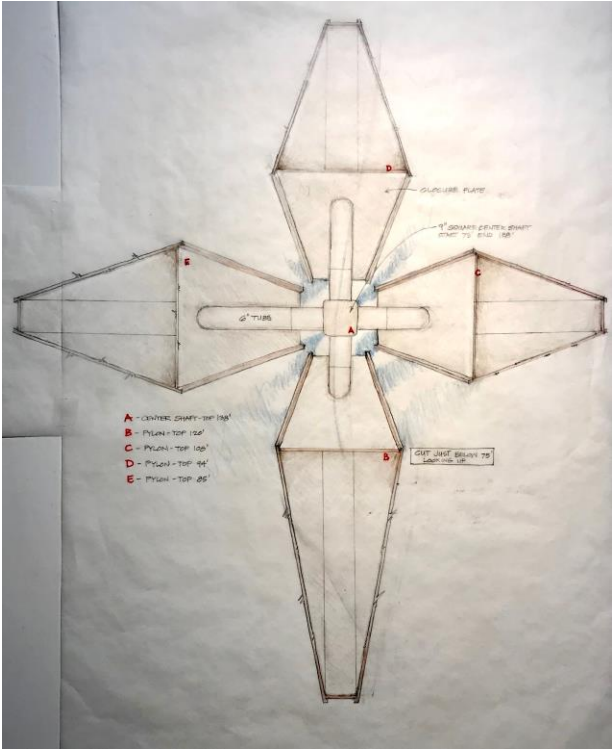


Section 2

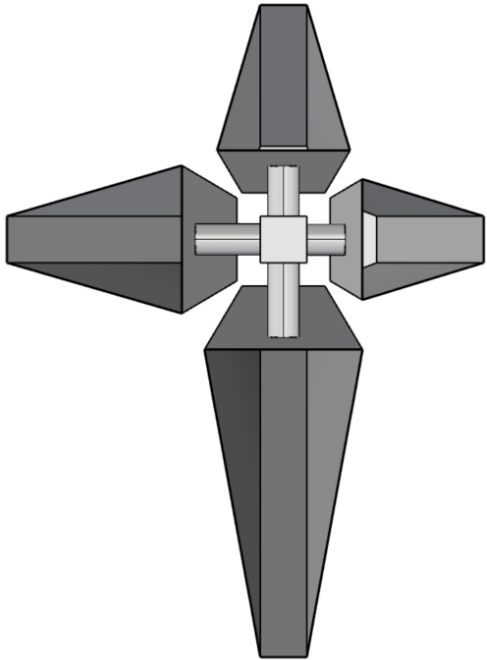
Current Scheme



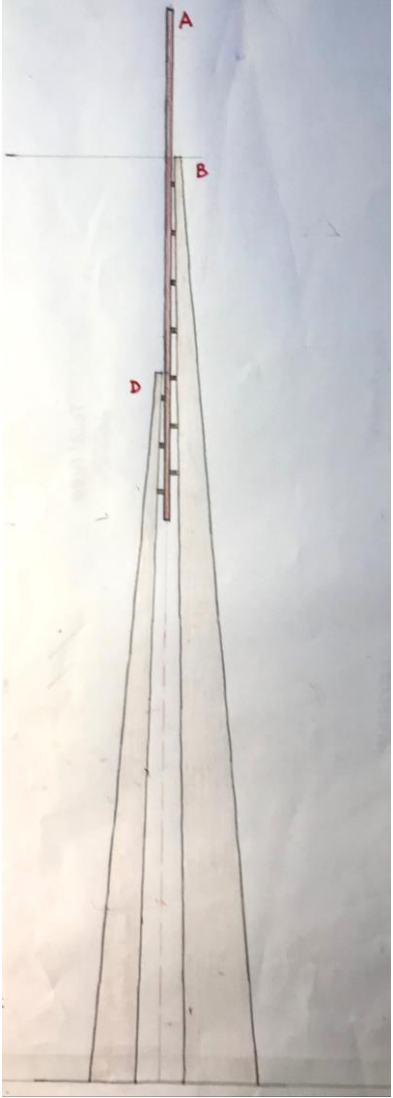
Base Plan



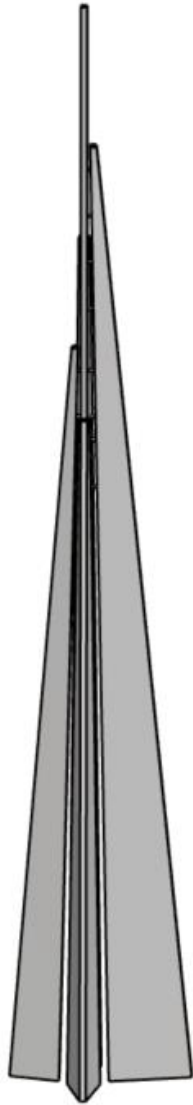
Section at mid-height



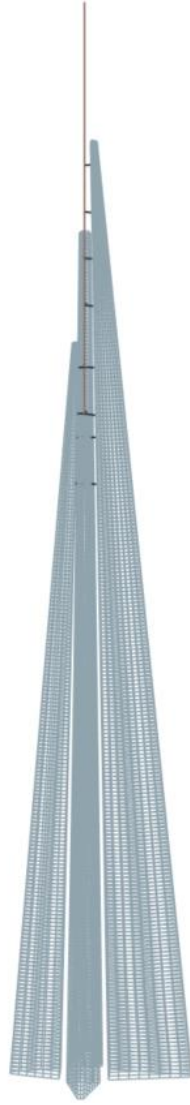
Current Scheme Development



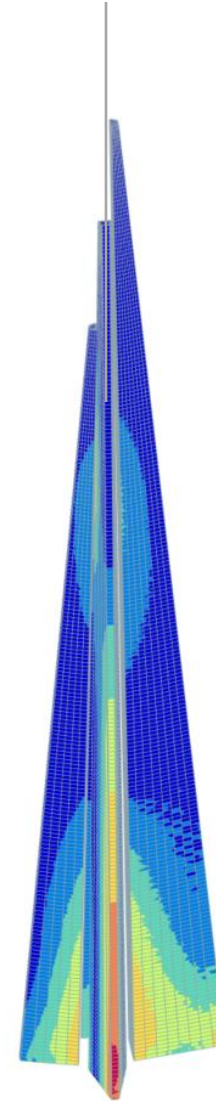
Architectural
Sketch



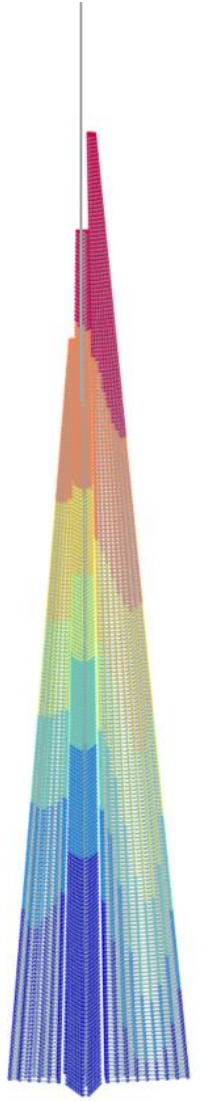
3D Computer
Model



3D Analysis Model



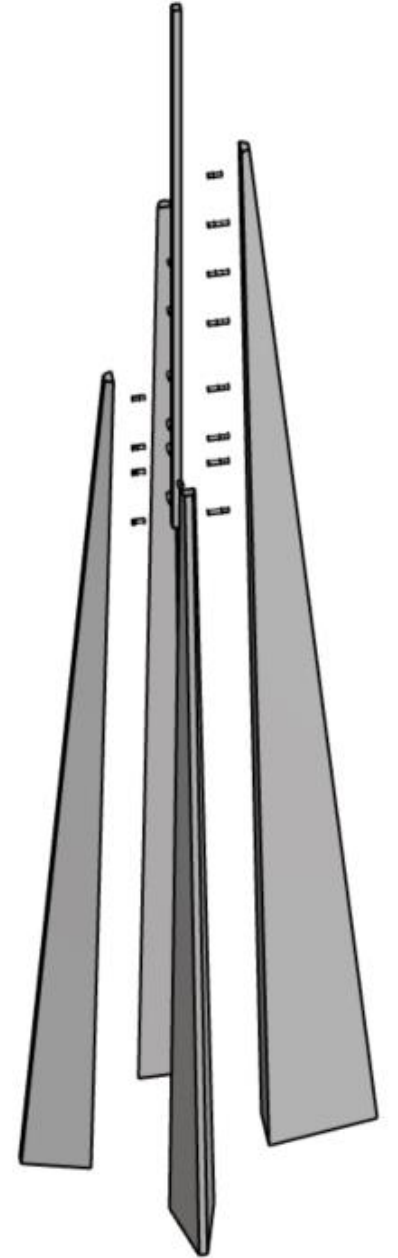
Analysis Results
Stresses



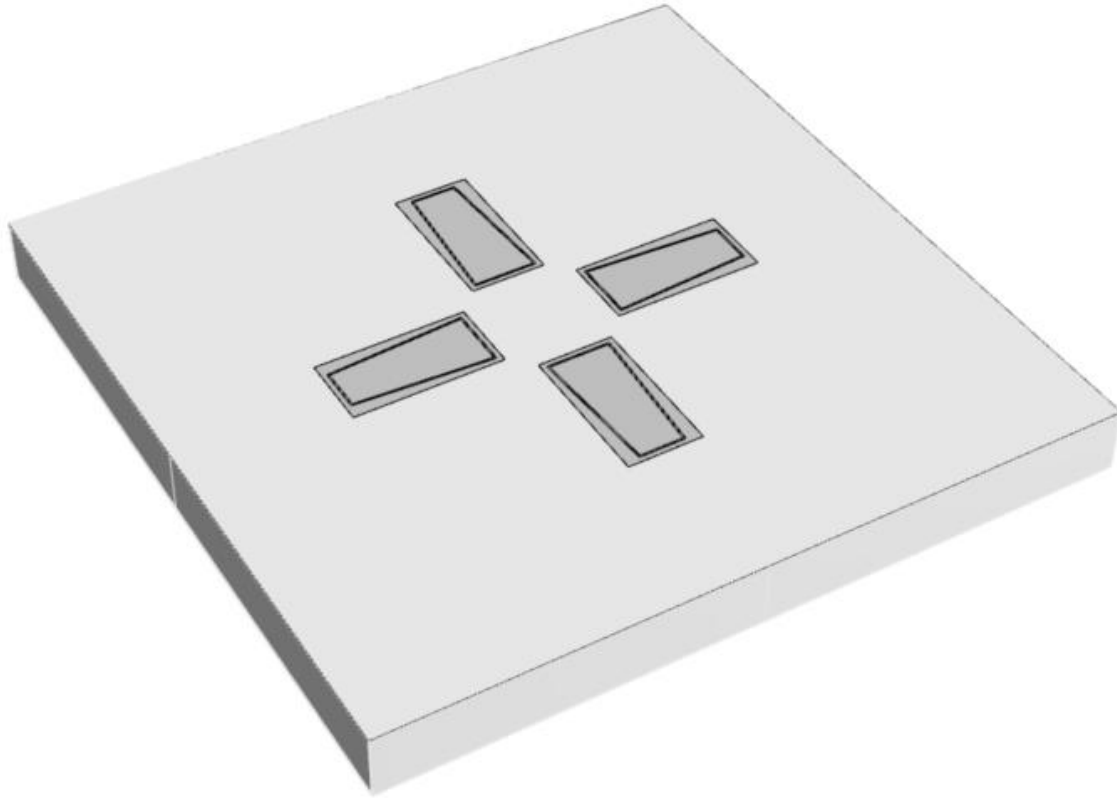
Analysis Results
Deflection

Advantages of Current Scheme

- All four pylons connected via center shaft
- Stiffer structure
- Material savings
- Trapezoidal sections give slim appearance while allowing for sufficient cross-sectional area
- Easier to construct



Foundation



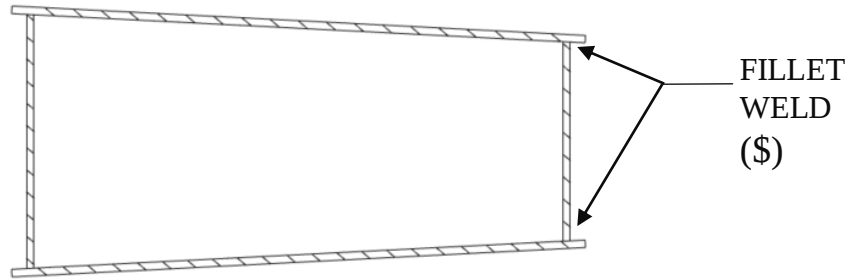
42 ft x 46 ft x 4 ft deep concrete pad



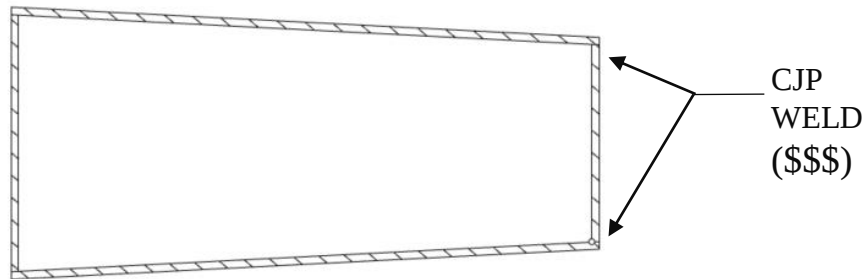
Steel base plates shop welded to each pylon

Trapezoidal Cross Sections

- Steel plates shop welded

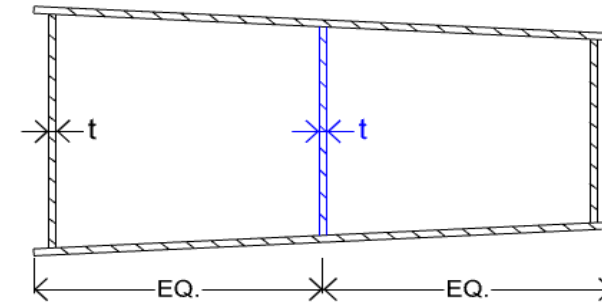


Inset plates



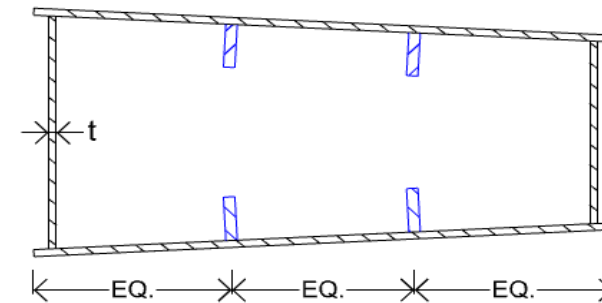
Flush outer edges

- Stiffening of deep cross sections



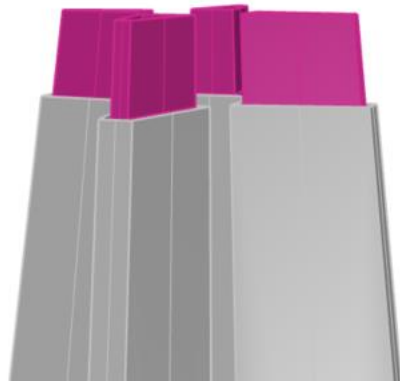
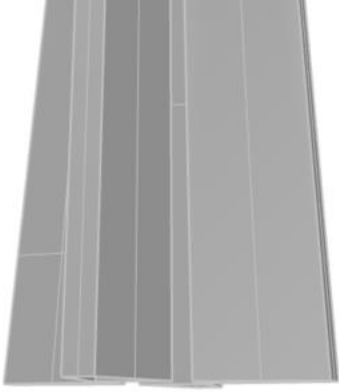
Full depth stiffener plate

$$t = \frac{1}{4}'' - 1''$$

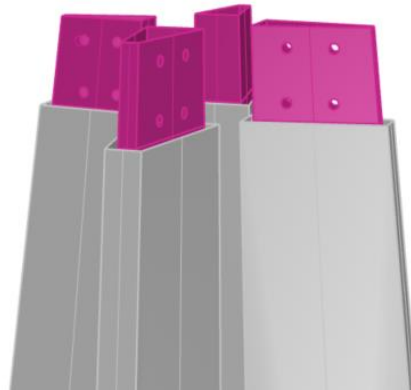
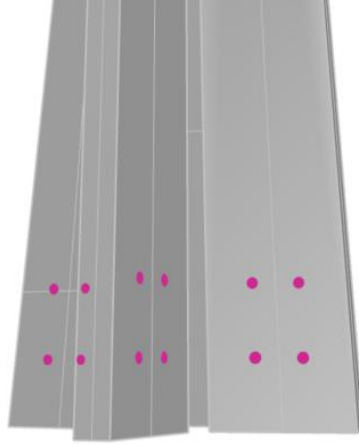


Short fins

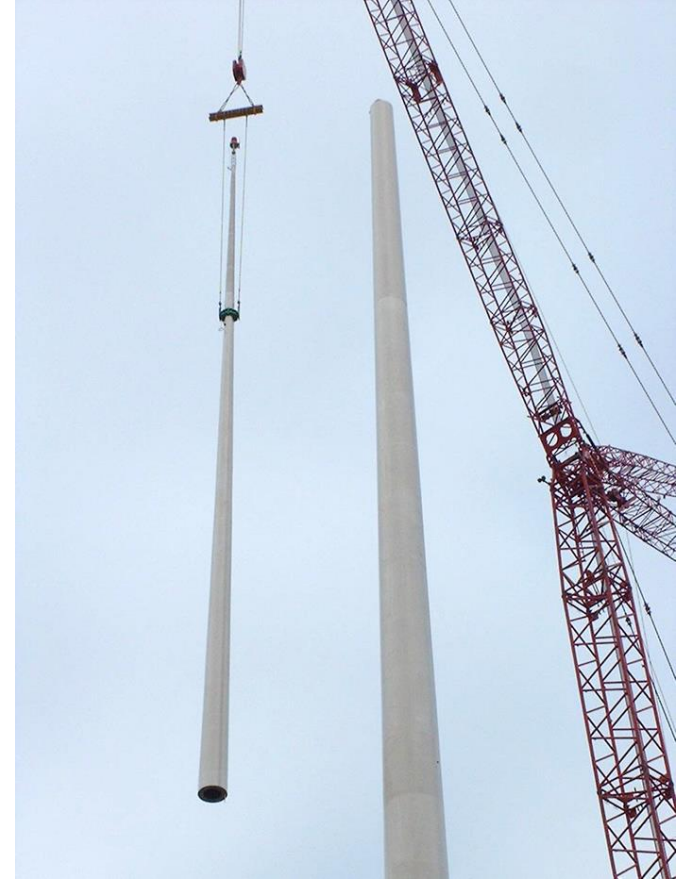
Splice Detailing



Welded
sleeve joint

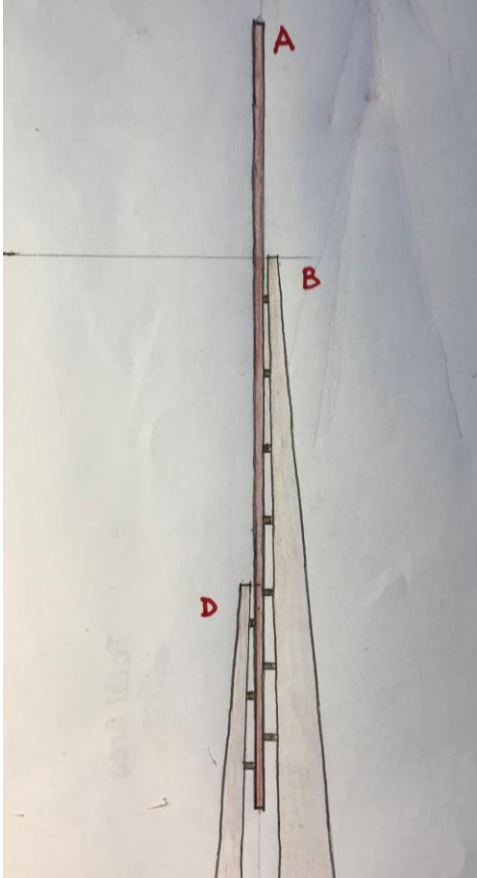


Through-bolted
sleeve joint

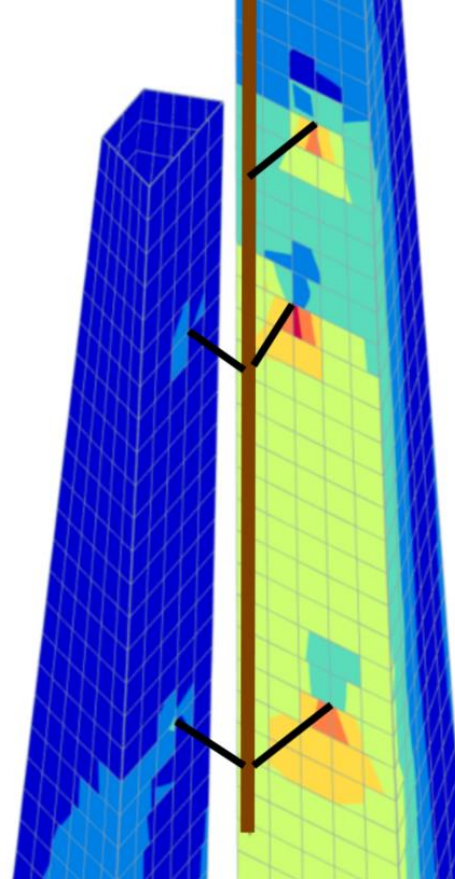


Crane lifts
pieces into place

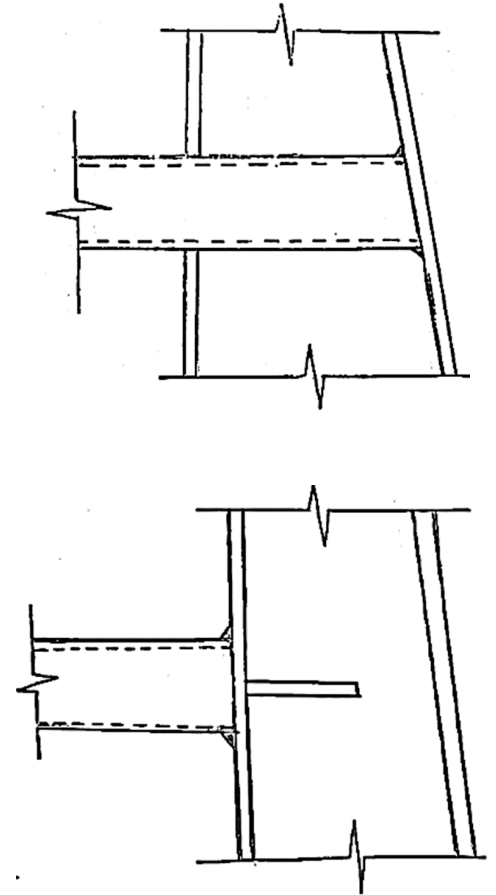
Connection to Shaft



Concept sketch

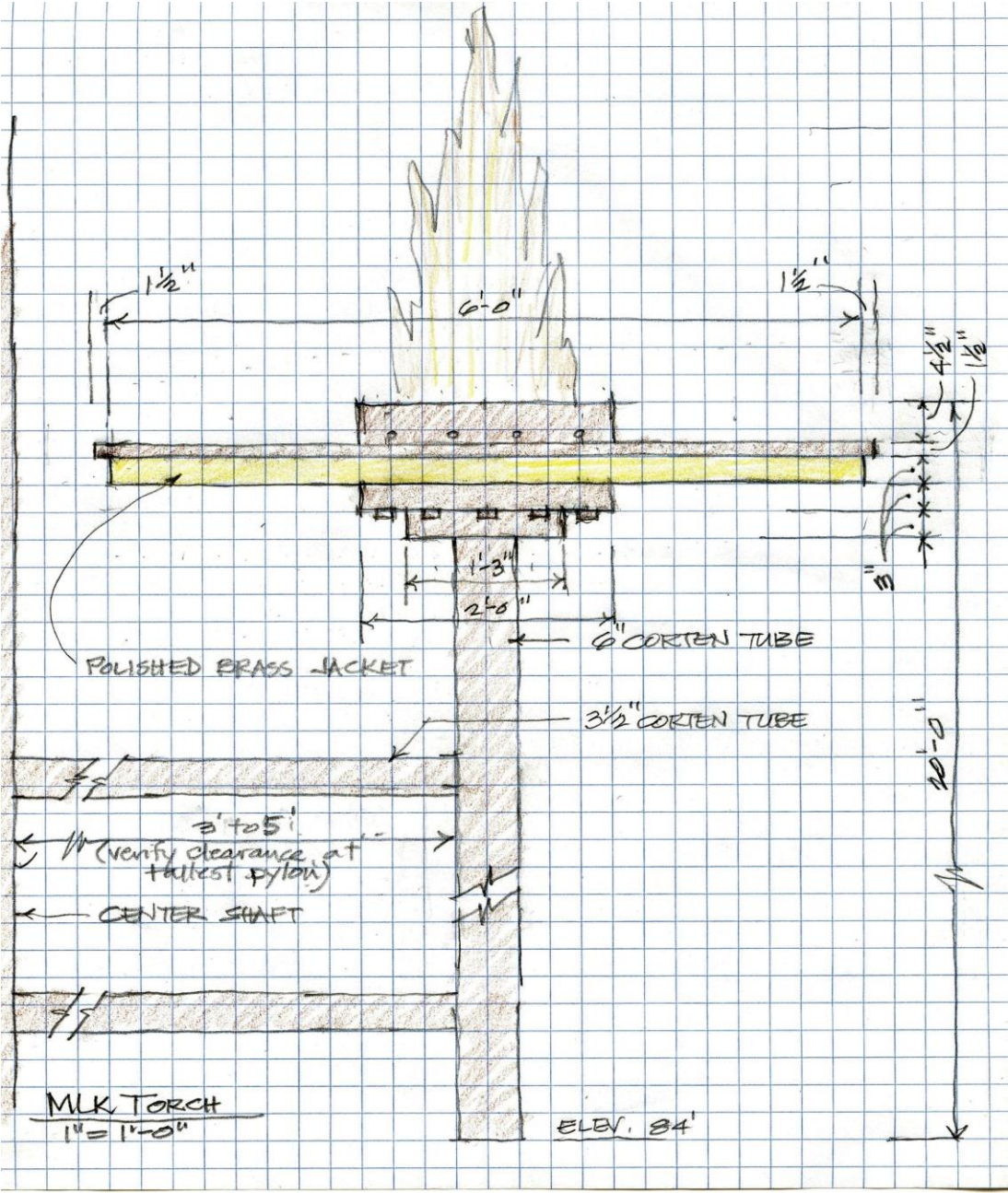
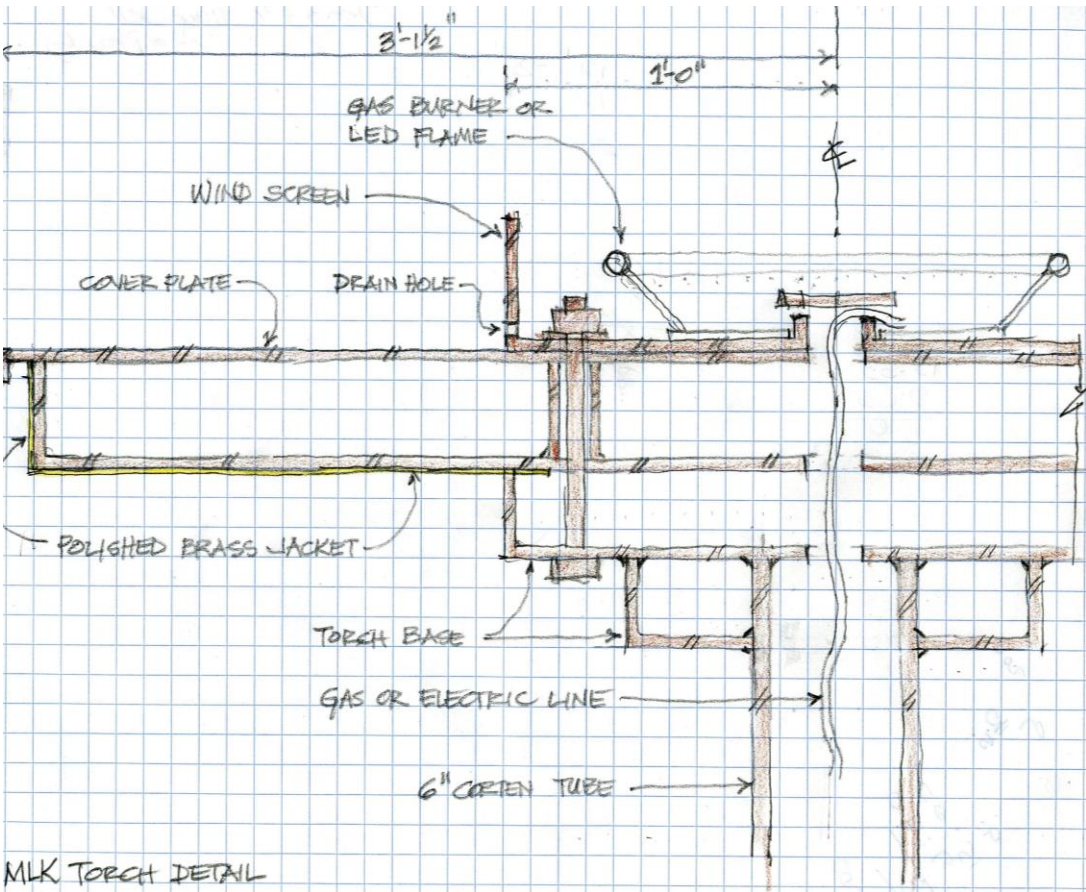


Stress concentrations



Detailing options

Torch Detailing



Material Selection

Corten Weathering Steel



International Bomber Command Center
Lincolnshire, UK



Richard Serra Sequence Sculpture
Palo Alto, CA

