Structural Systems Design for a Laramie Office Building

SENIOR HONORS PROJECT & STRUCTURAL SYSTEMS DESIGN CLASS

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Project Overview

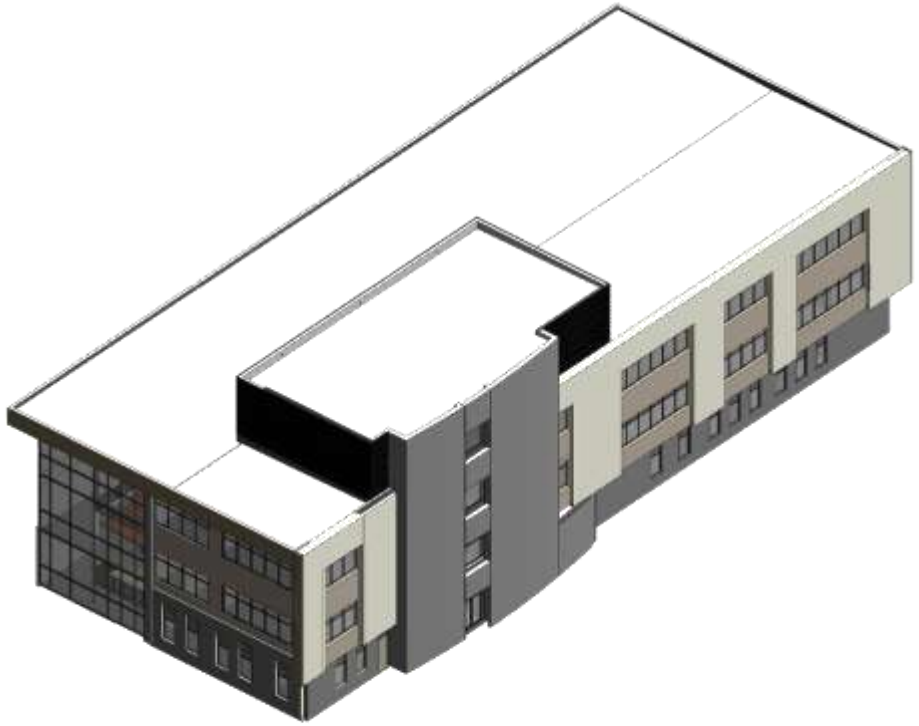
Structural System Design for an office building in Laramie

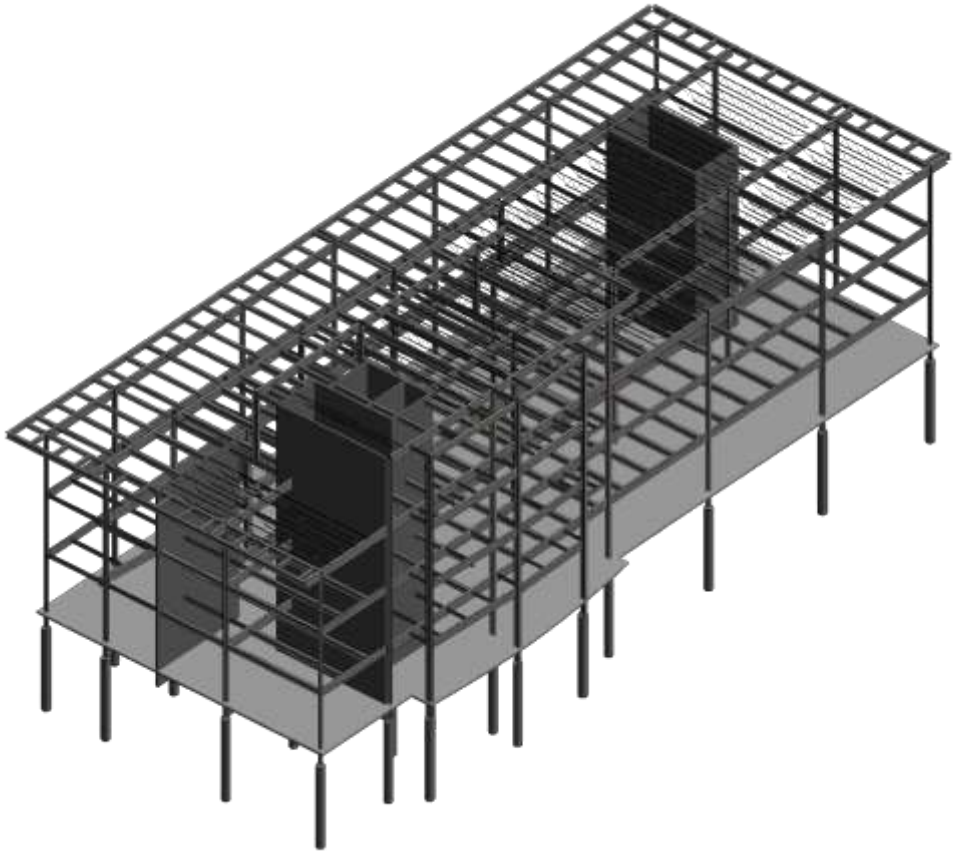
- Plans are a modified portion of the Marian H. Rochelle Gateway Center
- Included the design of:
  - Foundation System
  - Gravity Framing System
  - Lateral System
  - Exterior Cladding

Design required the use of documents from the following groups/institutes

- International Building Code (IBC)
- American Society of Civil Engineers (ASCE-7)
- American Institute of Steel Construction (AISC)
- American Concrete Institute (ACI)

Project Overview





Gravity System- Levels 2 & 3

Steel Wide Flange (WF) Columns- W12x72, W10x49, W8x40

Steel WF Girders- W24x84, W21x55

Steel WF Beams- W16x40, W12x20, W10x17

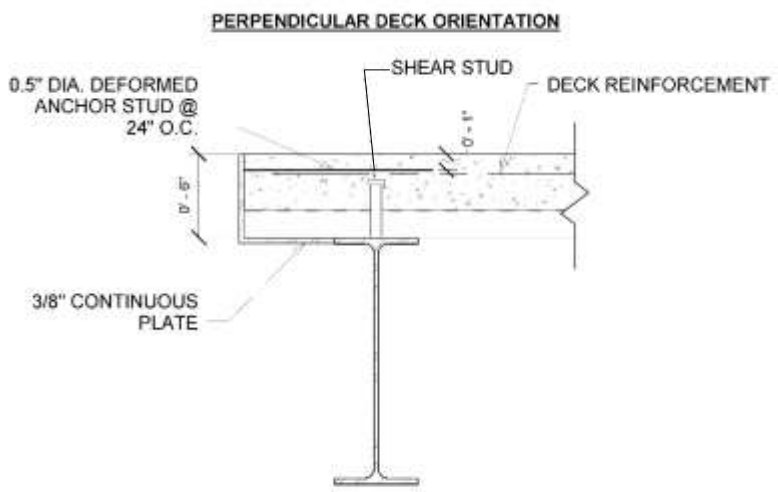
Composite Metal Deck

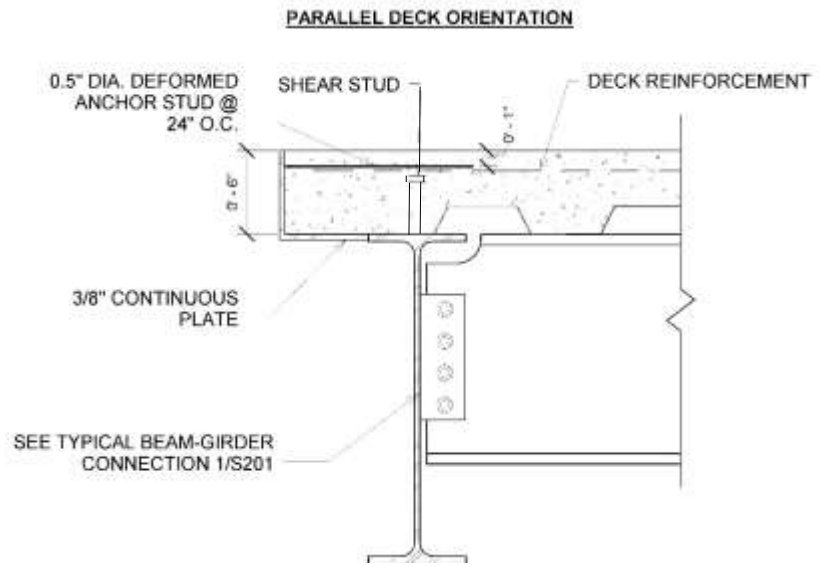
- 2VLI18
  - 2” Deep Flutes
  - 18 gage
- 4” Concrete
- Total depth of 6”
- Rigid diaphragm

Gravity System- Levels 2 & 3

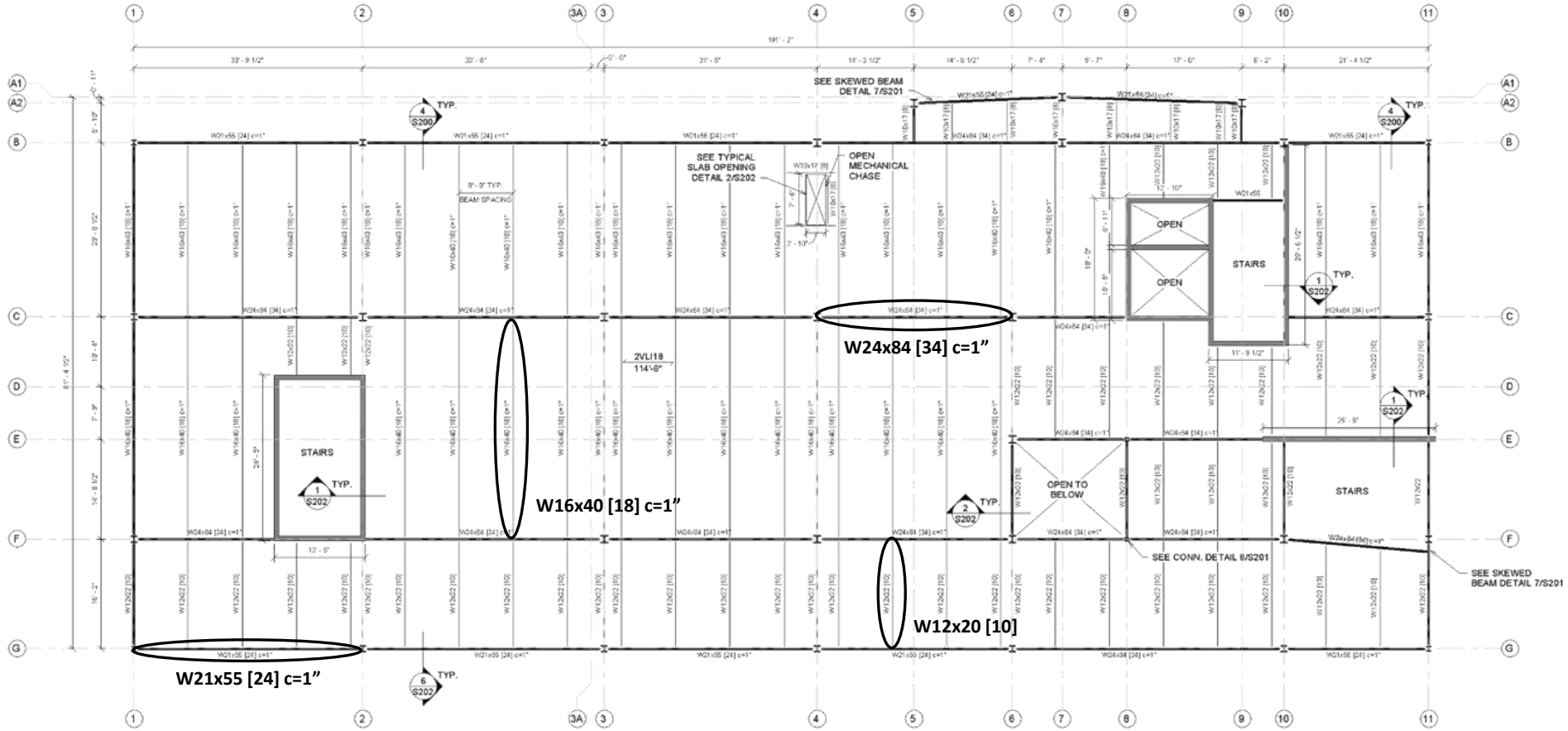
The framing is composed composite beams and girders

- Shear studs are welded through the metal deck and to the flange of the beams and girders
- Creates mechanical connection with the concrete deck
- Composite action increases the capacity of the beams and girders

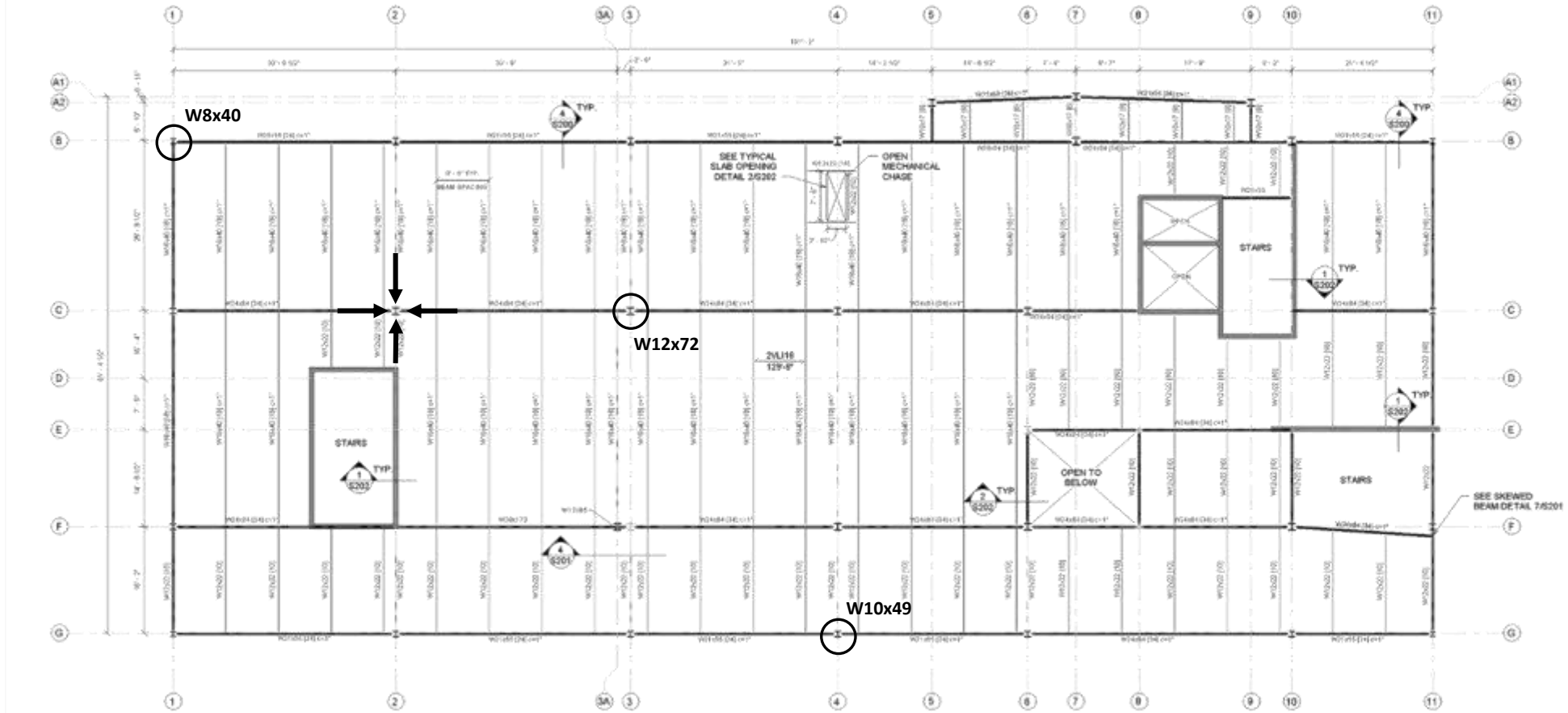




Gravity System- Level 2



Gravity System- Level 3



Gravity System- Roof

Consists of a combination of steel joists, beams, and girders

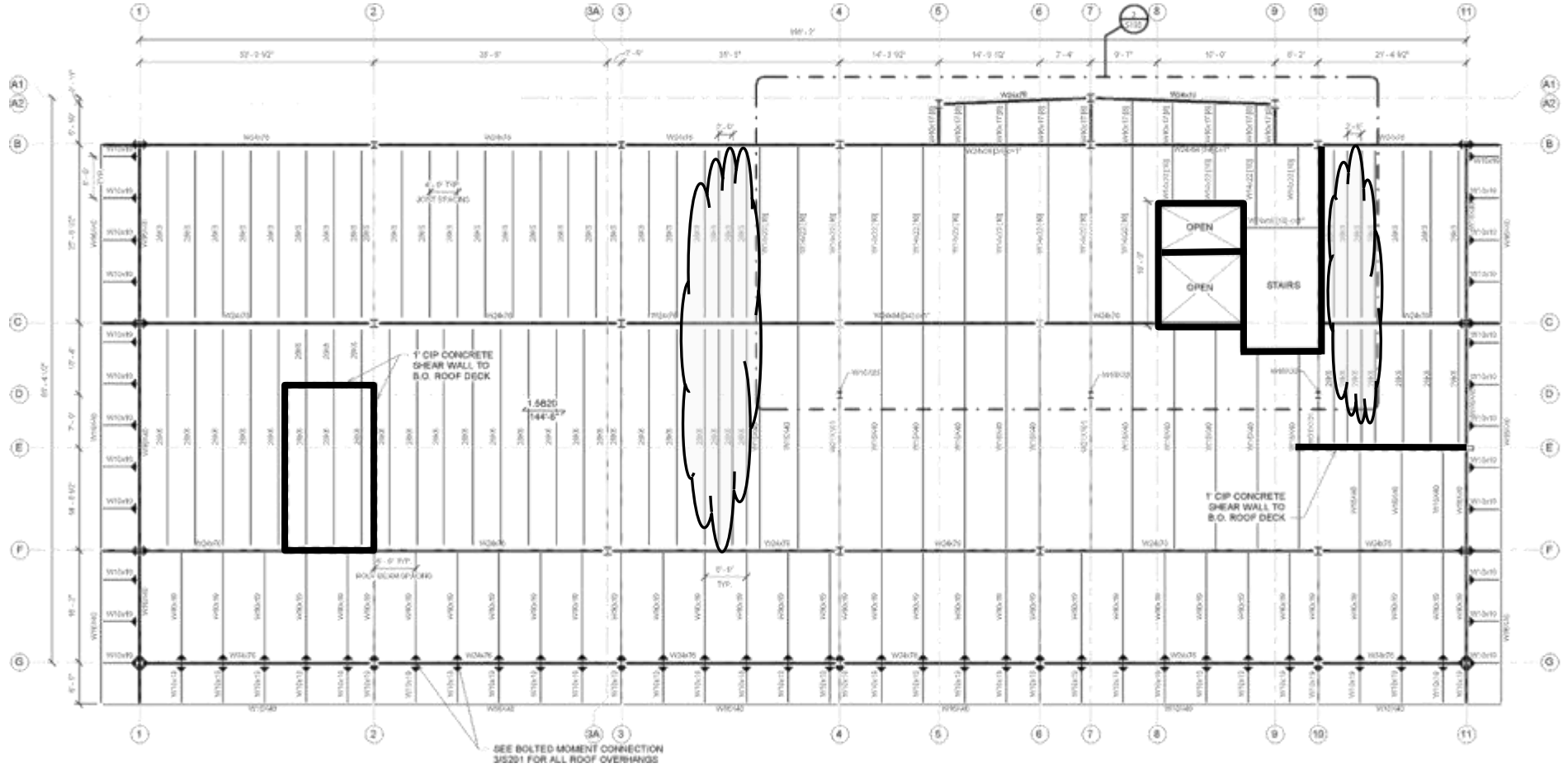
Roof does not contain concrete

- Thus, no composite action/shear studs are used on the roof
- The roof deck is a flexible diaphragm
- Composite beams and girders are used in the mechanical penthouse

There’s cantilevering portions of the roof where the roof parapet is

- Bolted moment connections are required in these locations

Gravity System- Roof



Lateral System

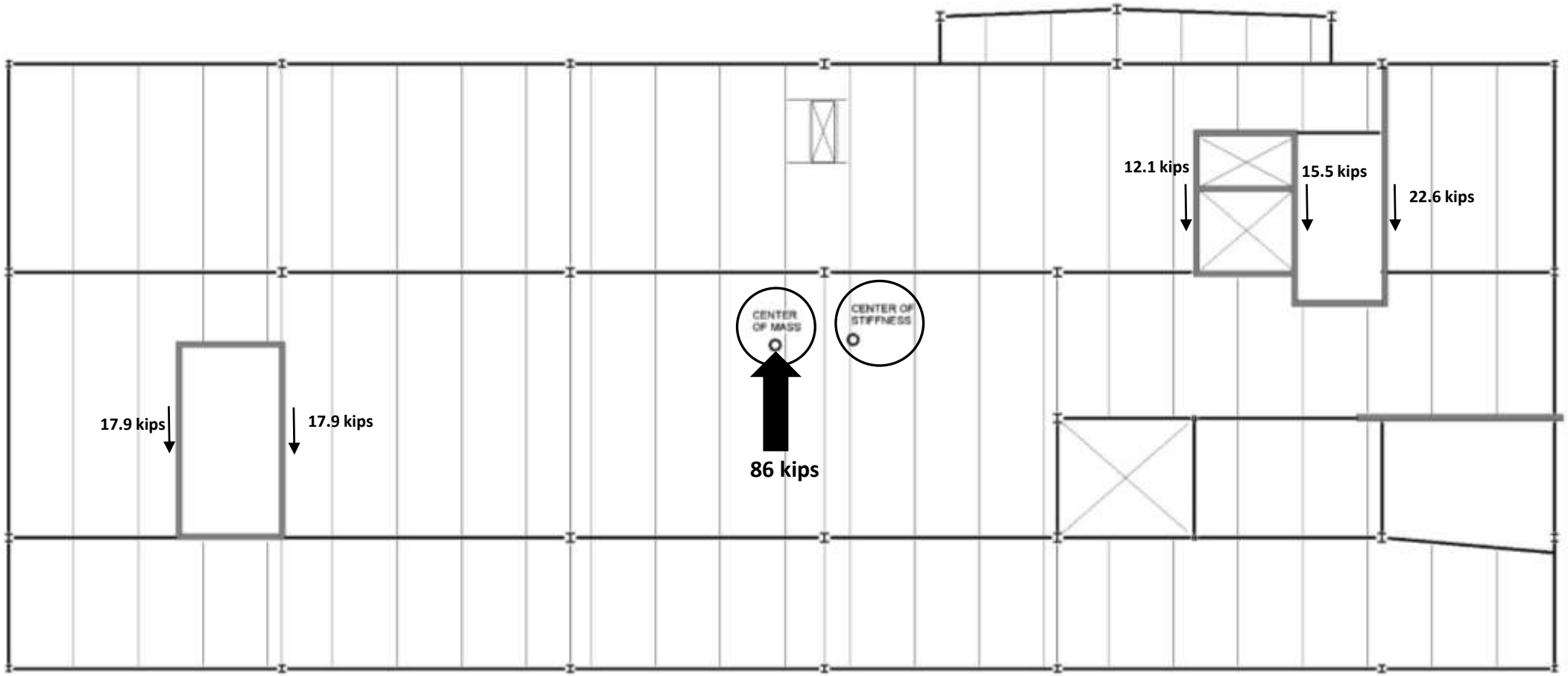
Cast-in-place concrete shear walls is the lateral system for the building

- Surrounds stairwells and elevator shafts
- Shear walls are continuous to the bottom of the roof deck
- There is not any braced or moment frames
- Thus, the steel columns act as “leaning columns”

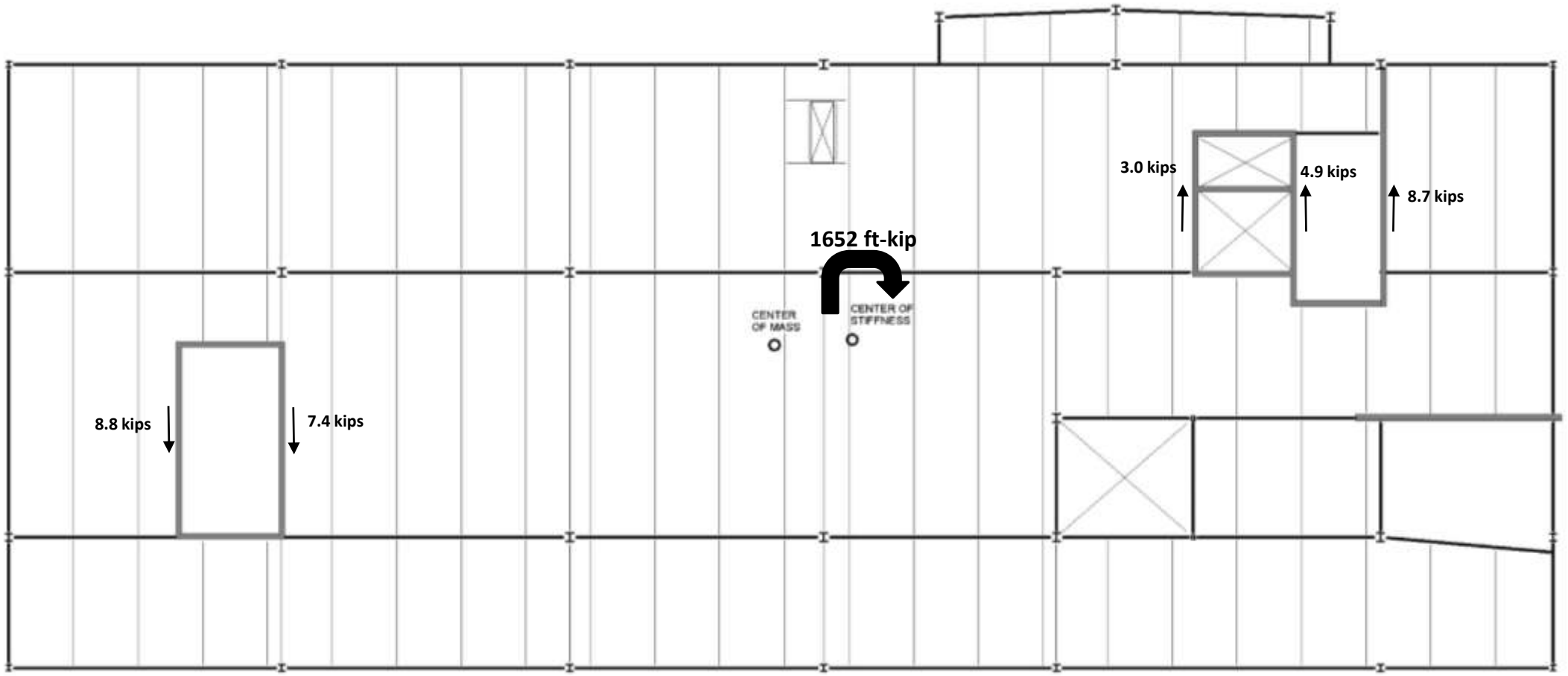
Shear wall reinforcement was designed for flexure and shear

- Continuous vertical #6 bars @ 1’ O.C.
- Continuous horizontal #6 bars @ 1’ O.C.

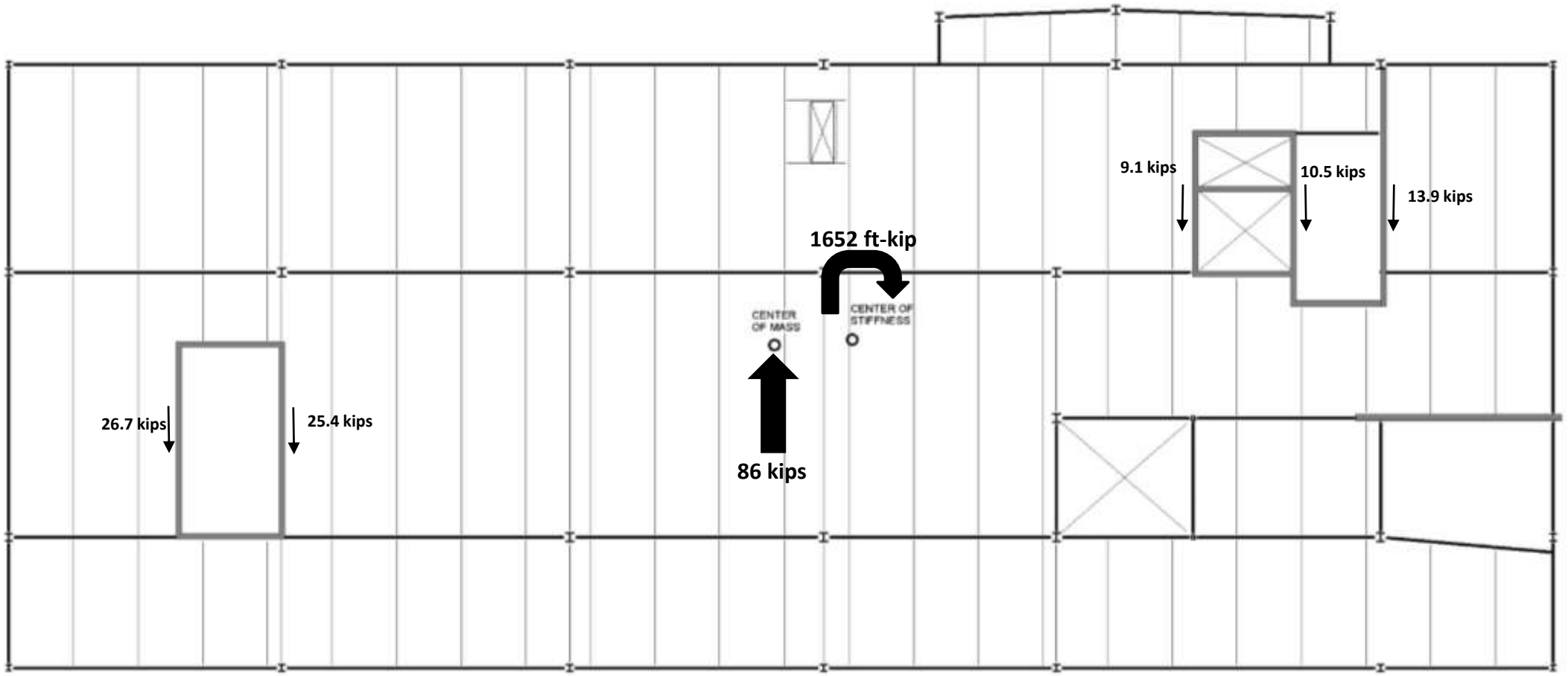
Level 2 Direct Shear



Level 2 Torsional Shear



Level 2 Total Shear

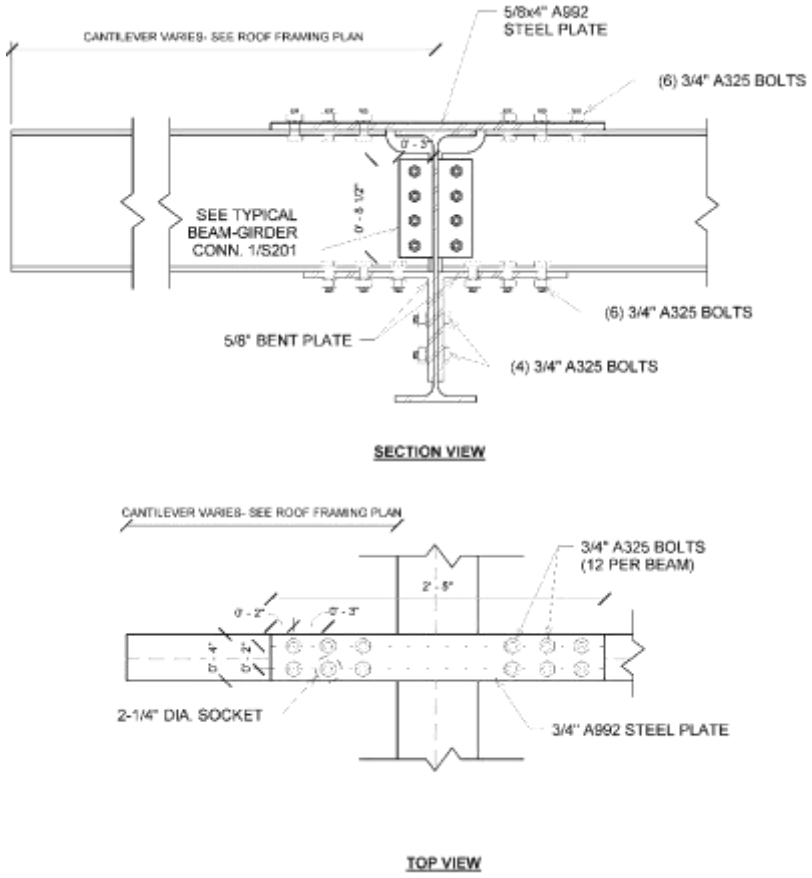


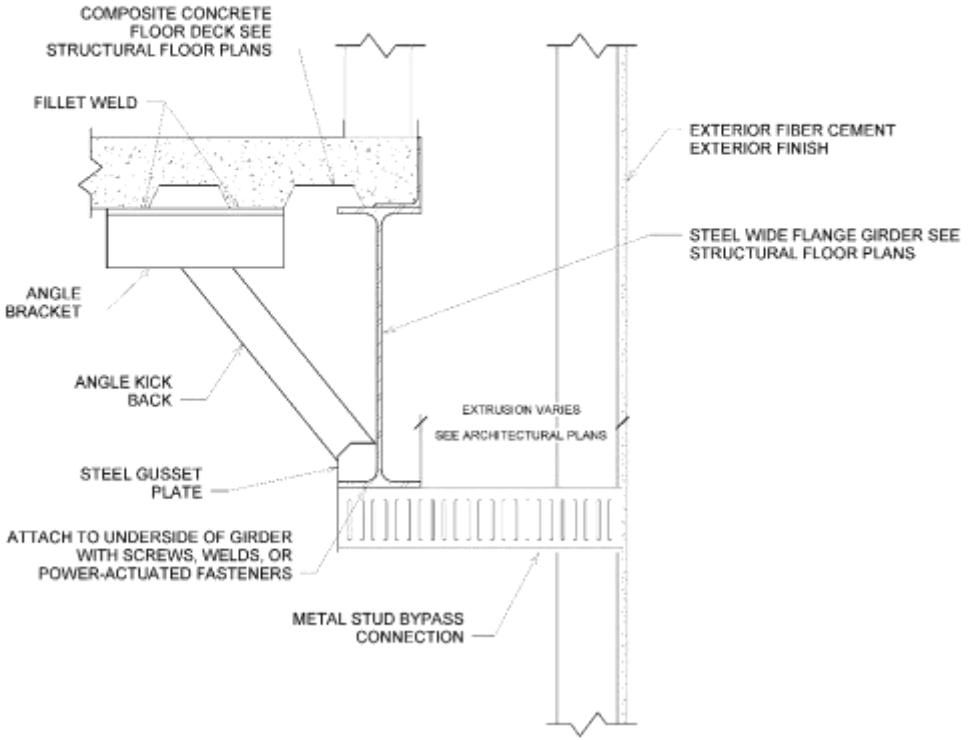
Detailing

Details produced included

- Column Base Plate
- Typical Beam-Girder Connection
- Typical Girder-Column Connection
- Transfer Beam
- Typical Extruded Wall Support
- Exterior Wall Framing Detail
- Shear Wall Reinforcement
- Shear Stud Layout
- Bolted Moment Connection

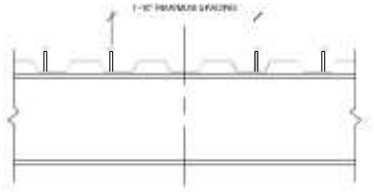
Detailing


CANTILEVER VARIES- SEE ROOF FRAMING PLAN
5/8x4" A992
STEEL PLATE
(6) 3/4" A325 BOLTS
SEE TYPICAL
BEAM-GIRDER
CONN. 1/S201
(6) 3/4" A325 BOLTS
5/8" BENT PLATE
(4) 3/4" A325 BOLTS
SECTION VIEW
CANTILEVER VARIES- SEE ROOF FRAMING PLAN
3/4" A325 BOLTS
(12 PER BEAM)
2-1/4" DIA. SOCKET
3/4" A992 STEEL PLATE
TOP VIEW

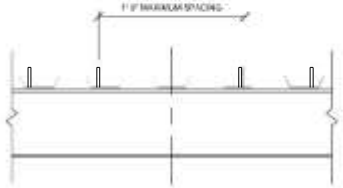

COMPOSITE CONCRETE
FLOOR DECK SEE
STRUCTURAL FLOOR PLANS
FILLET WELD
EXTERIOR FIBER CEMENT
EXTERIOR FINISH
STEEL WIDE FLANGE GIRDER SEE
STRUCTURAL FLOOR PLANS
ANGLE
BRACKET
ANGLE KICK
BACK
EXTRUSION VARIES
SEE ARCHITECTURAL PLANS
STEEL GUSSET
PLATE
ATTACH TO UNDERSIDE OF GIRDER
WITH SCREWS, WELDS, OR
POWER-ACTUATED FASTENERS
METAL STUD BYPASS
CONNECTION

Detailing

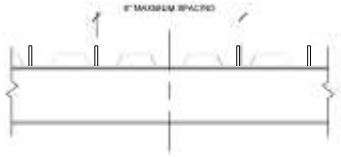
W16x40
CASE 1: GREATER THAN 18' SPAN
18 TOTAL 3/4" DIA. SHEAR STUDS REQUIRED
SPACE EVENLY WITH A MAXIMUM OF ONE STUD FOR A SINGLE RIB



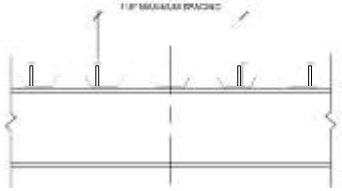
W12x22
CASE 2: 14'≤SPAN≤18'
10 TOTAL 3/4" DIA. SHEAR STUDS REQUIRED
SPACE EVENLY WITH A MAXIMUM OF ONE SHEAR STUD PER RIB



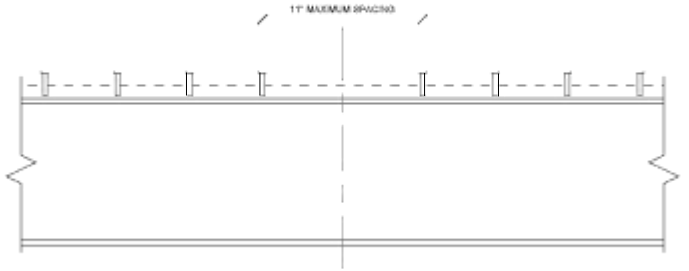
W10x19
CASE 3: SPAN≤8'
8 TOTAL 3/4" DIA. SHEAR STUDS REQUIRED
SPACE EVENLY WITH A MAXIMUM OF ONE SHEAR STUD PER RIB



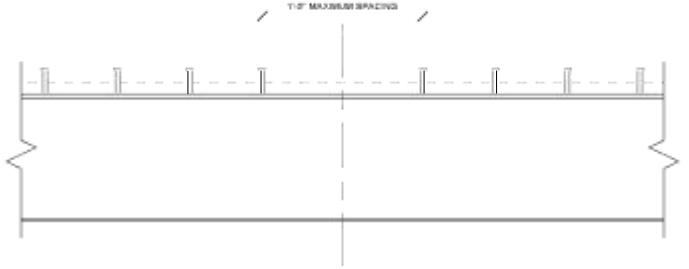
W14x22
CASE 4: 12'≤SPAN≤26' (IN MECHANICAL PENTHOUSE)
10 TOTAL 3/4" DIA. SHEAR STUDS REQUIRED
SPACE EVENLY WITH A MAXIMUM OF ONE SHEAR STUD PER RIB



W28x84
CASE 1: INTERIOR GIRDER
34 TOTAL 3/4" DIA. SHEAR STUDS REQUIRED
SPACE EVENLY IN A SINGLE RIB



W21x55
CASE 2: EXTERIOR GIRDER
24 TOTAL 3/4" DIA. SHEAR STUDS REQUIRED
SPACE EVENLY IN A SINGLE RIB



Questions?

Thank You