Basis of Design

- This section applies to roofing membranes, flashing and accessories.

Design Criteria

- Adhere to the standards and details of the latest editions of the National Roofing Contractors Association (NRCA) handbook and the Sheet Metal & Air Conditioning Contractors Association (SMACNA) manual.
- All systems shall be familiar and proven in the field, compatible with existing roofs, and maintainable by the University's roof maintenance shop. The systems should rely on slope and multiple plies to achieve performance.
- All components of the roofing systems shall be asbestos free.
- Provide a vapor barrier on low slope roofs to act as a secondary membrane when the primary roofing fails. As a minimum requirement, provide a single layer of 30# felt set in bitumen. At the Contractor's option, the vapor barrier may be the temporary roof. When the permanent roof is installed, the vapor barrier shall be patched to new weatherproof condition or replaced.
- Designs shall deter easy roof access except for periodic inspection and maintenance by authorized personnel. The design shall limit casual access through windows, over parapet walls and other points.
- Rock or gravel ballasted roofs are not acceptable.
- Parapets shall have permanent waterproof coping, flashing or capstones.
    1) Cover all parapets' back vertical surface with a moisture protection membrane that extends over the top of the parapet.
    2) Parapets with capstones or masonry shall have through wall flashing over the moisture protection membrane.
    3) Secure capstones to the parapet with stainless steel dowels. Seal dowels at through wall flashing with flexible flashing and sealant.
- Termination of the roofing or moisture protection membrane at walls and/or parapets shall be by termination bar and flashing or flashing and counter flashing in a reglet.
- Specify Energy Star certified roofing systems. Energy Star roofing systems have a high-reflectance and high emissivity (initial reflectance of at least 0.65 and three year age reflectance of at least 0.5 when tested in accordance with ASTM E903 and emissivity of at least 0.9 when tested in accordance with ASTM 408). Reflective roofing systems decrease the amount of dark, non-reflective on-site and thereby reduce the urban heat island effect.
- Consider the installation of green roofing systems as a strategy to reduce the storm water runoff, warming of urban environments, and to increase thermal performance of buildings, thereby reducing energy consumption.
- Where possible specify the use of flat roof surfaces for storm water detention. Confirm with structural. Captured rainwater can be reused on-site for irrigation purpose.
- When elevators are upgraded provide a reflective roof coating at the machine room to reduce heat gain.

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Drainage

- Slope the structural roof deck to provide drainage; minimum slope is ¼ inch per one foot.
- Where the roof slopes to the exterior parapet wall, provide exposed scupper systems; then if a drain is clogged the visible water running down the side of a building attracts attention and assures prompt action.
- Where drains are not located at the exterior wall, they shall be at points of maximum deflection of the structural roof deck. Drains shall be located off of centerline to minimize interference with columns, beams and bearing walls. All drains and overflow drains shall be located in a sump.
- Flash all drains with 4 lb. per square foot sheet lead in addition to the membrane flashing.
- Design gutter systems according to SMACNA as a minimum recommended standard.

Flashing

- Metal flashing shall be minimum thickness as follows: Stainless steel, 24Ga. (.018 inch); Cooper, 16oz. per square foot; Coated galvanized steel, 24Ga (before coating and galvanizing); Aluminum, .032 inch.
- Coatings for flashing shall be high-performance coatings, e.g. epoxy, polyurethane and fluoropolymer.
- All flashing shall be designed to accommodate expansion without buckling, “oilcanning”, or warping. Provide standing seam joints in copings unless material thickness prevents the forming of a watertight coping joint.
- At high slope roofs provide flexible sheet flashing at roof perimeter, under closed valleys, ridges and saddles. Provide metal flashing at open valleys.

Accessories

- Provide joints that accommodate all movement of the structure. These joints include but are not limited to seismic, thermal expansion, building joints, etc.
- All joints where movement is anticipated shall have a primary barrier with an architectural cover, and a secondary drainage barrier (gutter) that drains to the exterior.
    1) These joints shall have an 8-inch curb above the roof surface.
    2) They shall be flashed with flexible or stainless steel flashing and counterflashing and tied to through wall flashing.
    3) The structural deck shall slope away or be parallel to the joints.
    4) All corners and horizontal to vertical transitions shall be fabricated in one piece.
- Skylights and roof hatches shall have curbs that extend a minimum 1’ 0” above the roof surface. Provide crickets to prevent ponding.

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- Roof mounted equipment is not desired. The intent is to place all equipment within a penthouse to reduce foot traffic and therefore reduce leaks.
    1) If roof mounted equipment is unavoidable, the support base shall be either a concrete slab designed for the specific equipment and tied into the structural deck or a stand according to attached drawings "Mechanical Equipment Stand and Insulated Deck Steel Frame" or a curb 1'-0" above roof, minimum.
    2) All equipment shall have vibration dampening/isolation and seismic restraints. Where a concrete pad is provided it shall resist seismic forces, be a minimum of 4 inches thick, reinforced and secured to the structure deck.
- Penthouse wall roof base and flexible flashing should extend up a minimum 1' 0" and terminate with a termination bar and counter flashing. All penthouses shall have direct access from within the building.
- Roofs that require foot traffic shall be designed with the walking surfaces extending from the access point to equipment, ladders, etc. All walkways shall have protective walk surfaces.
- Provide fall protection for safe worker access to the façade of the building, for window washing and for working on the exterior and roof of a building. Provision for worker access to the façade must be complete and can be from the roof and/or from the areas adjacent to the building. These two provisions must be compatible and can be the same system. Refer to attached drawings for Fall Arrest Anchors.
- Coordinate with the University for determining if a lightning protection system is required.

Fall Arrest Systems

- If a parapet is used as a fall protection system it shall be a minimum of 42 inches above the roof surface at all points.
- The design, fabrication and installation of each anchor and lifeline are the responsibility of the Design Consultant and must comply with referenced codes and standards. Fall arrest anchors and their attachment to the building must be of materials that will not rot, corrode, or deteriorate in any way. Locations of the anchors must be approved by University project review prior to completion of building design.
- Design anchors and their attachment points to withstand a horizontal load in any direction of at least 5,000 pounds.
- Fall arrest anchors shall be based on the designs shown in Drawings-Typical Fall Arrest Anchors unless there is a structural reason why these are not acceptable. "Off-the-shelf" fall protection systems are not acceptable unless entire system, including attachment to building structure, is designed and warranted by the manufacturer.
- Vertical lifelines (droplines) shall have a minimum tensile strength of 5,000 pounds.
- Horizontal lifelines shall have a tensile strength capable of supporting a horizontal fall impact load of at least 5,000 pounds, applied anywhere along the lifeline.
- Factors to include in the design include the number of anchors and the amount of slack in the horizontal line. To protect the roof and rope from abrasion, the rope should not contact the roof surface. Provide slack in the lifeline to prevent the loads from exceeding the strength of the anchors.

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- Design all anchors to withstand a horizontal load in any direction of at least 5,000 pounds; the end anchors may need to be stronger. The location of the leading edge lifeline must be at least six feet from the roof edge; we prefer as close to six feet as possible. Maximum deflection distance of the lifeline under load is not specified, but it must not deflect more than the distance from the anchor to the roof edge.

Skylights & Roof Hatches

- Skylights and roof hatches shall have curbs that extend a minimum 1' 0" above the roof surface. Provide crickets to prevent ponding.
- Access to all skylight surfaces, both inside and out, must not put personnel at risk and shall not require that personnel bring equipment such as ladders or lifts unless approved by University plan review. Further design requirements include the following:
- All skylights shall meet OSHA requirements for fall protection.
- Wherever there is danger of falling through a skylight opening, and the skylight is not capable of sustaining the weight of a two hundred pound person with a safety factor of four, the skylight opening must be guarded by a standard skylight screen or a fixed standard railing on all exposed sides.
- Skylight screens must be of such construction and mounting that they are capable of supporting the maximum potential load but never less than 200 pounds (with a safety factor of four).
- Skylight screens shall also be of such construction and mounting that under ordinary loads or impacts, they will not deflect downward sufficiently to break the glass below them.
- Skylight screens shall be constructed of grillwork with openings not more than four inches long or of slatwork with openings not more than 2 inches unrestricted length.
- Access ladders from roof hatches shall have a extension, per OHSA regulations, to provide safe access to the roof.

Design Evaluation

The following information is required to evaluate the roofing design:

- Schematic Design Phase: Indicate overall design concept for thermal control and roofing. Provide a conceptual description of all the materials to be used and their location.
- Design Development Phase: Provide information that indicates a complete roof design and includes positive drainage. Provide information on the drainage system that shows how it will function. Provide detailed information that clearly indicates how the various roof components relate to one another, including but not limited to edge, ridge and valley conditions and penetrations by mechanical, electrical, structural and architectural components. Outline specifications.
- Construction Document Phase: Complete design and final specifications.

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Submittals

The following submittals are required by the University as a minimum from the Contractor:

- Shop drawings indicating the complete design with all components
- Complete list of all the materials and items proposed for complete system installation including product data, samples and Material Safety Data Sheets (MSDS)
- Letter from roofing manufacturer confirming compatibility of all proposed products, including insulation, sealants and mastics
- Manufacturer's installation instructions and modifications required to meet manufacturer's warranties
- Application schedule

Related Sections

- Facilities Services Design Guide - Thermal & Moisture Protection

Products, Materials and Equipment

- Any products, material and/or equipment by a nationally recognized manufacturer are acceptable. Provide Energy Star roofing systems if a LEED rating is being pursued. Consider for all other roofing applications, i.e. projects that only include reproofing
- Any proven single or multi-ply system is acceptable for low slope roofs. PVC membrane roofing systems are undesirable due to the slippery nature when wet.
- Natural Slate, minimum 24 ga. metal with a high performance coating, architectural grade composition shingles, fired clay and concrete tile are acceptable systems for high slope roofs.
- Coal tar roofing systems are not acceptable on campus.
- Hot applied bitumen roofing systems need careful consideration for use on campus because of odors. Careful consideration must be taken in regards to location and prevailing winds if this system is proposed. "Torch-down" modified bitumen roofing system is an acceptable alternative due to lower odors. Hot applied bitumen roofing systems are not acceptable at the University Medical Center or Health Science Center.
- Roofing systems applied with adhesives that release high amounts of solvents need careful consideration for use on campus because of odors. Research and coordination with Environmental Health and Safety is necessary for an acceptable system.

Warranties

- In addition to the requirements of the General Conditions of the contract, a written guarantee is required by the University. It shall be signed by the Contractor, agreeing to maintain the roofing system installation in a watertight condition for at least two years from the date of final acceptance of the work by the University at no cost. Further, Contractor guarantees that all workmanship and materials in the roofing system are as specified and as recommended by the manufacturer.

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- The material manufacturers shall provide a written warranty, including flashing endorsement, for a period of ten years from date of final project acceptance, and agrees to provide all labor and materials necessary to correct all defects in the roofing system, including water penetration or abnormal deterioration of materials. Warranty also includes the responsibility for removal and replacement of all work concealing the roofing system.

Manufacturer's Qualifications

- Must be nationally recognized manufacturer in good standing with the National Roofing Contractors Association
- There must be at least five approved installers of proposed system within 200 miles of the project site.
- Manufacturer has an engineering service representative available full time to conduct daily inspection of application
- Manufacturer has five installations similar to proposed system within 200 miles of the University

Installation, Fabrication and Construction

- Installation shall be in accordance with technical specifications of the system manufacturer.
- Protect the roof system until final acceptance of the project. Restrict construction traffic and protect the roof from damage. Methods include but are not limited to protective walkways that are continuous and without gaps, prohibiting work on the finished roof or providing working surfaces.
- Approval from the University shall be required by equipment contractors for movement of all equipment too heavy for one person to move on the roof deck. Specific methods and procedures for transportation and setting equipment are required for approval.
- Temporary roofing installed for the convenience of closing in the building shall be at the Contractor's option. The temporary roofing shall be removed if not installed as part of the designed permanent roof or repaired to weather-tight condition if installed as part of the designed permanent roof.

Installer's Qualifications

- Must be certified by the manufacturer to install proposed system

Testing and Warranties

- As part of the final inspection and acceptance procedure, a moisture analysis and roof cuts are required. At two months prior to expiration of the 2-year roofing contractor warranty, the same tests are required. If defects are discovered the Contractor shall provide and pay for repairs as indicated in warranty.
- The University will engage an observer to monitor the installation of the roofing system.

END OF DESIGN GUIDE SECTION

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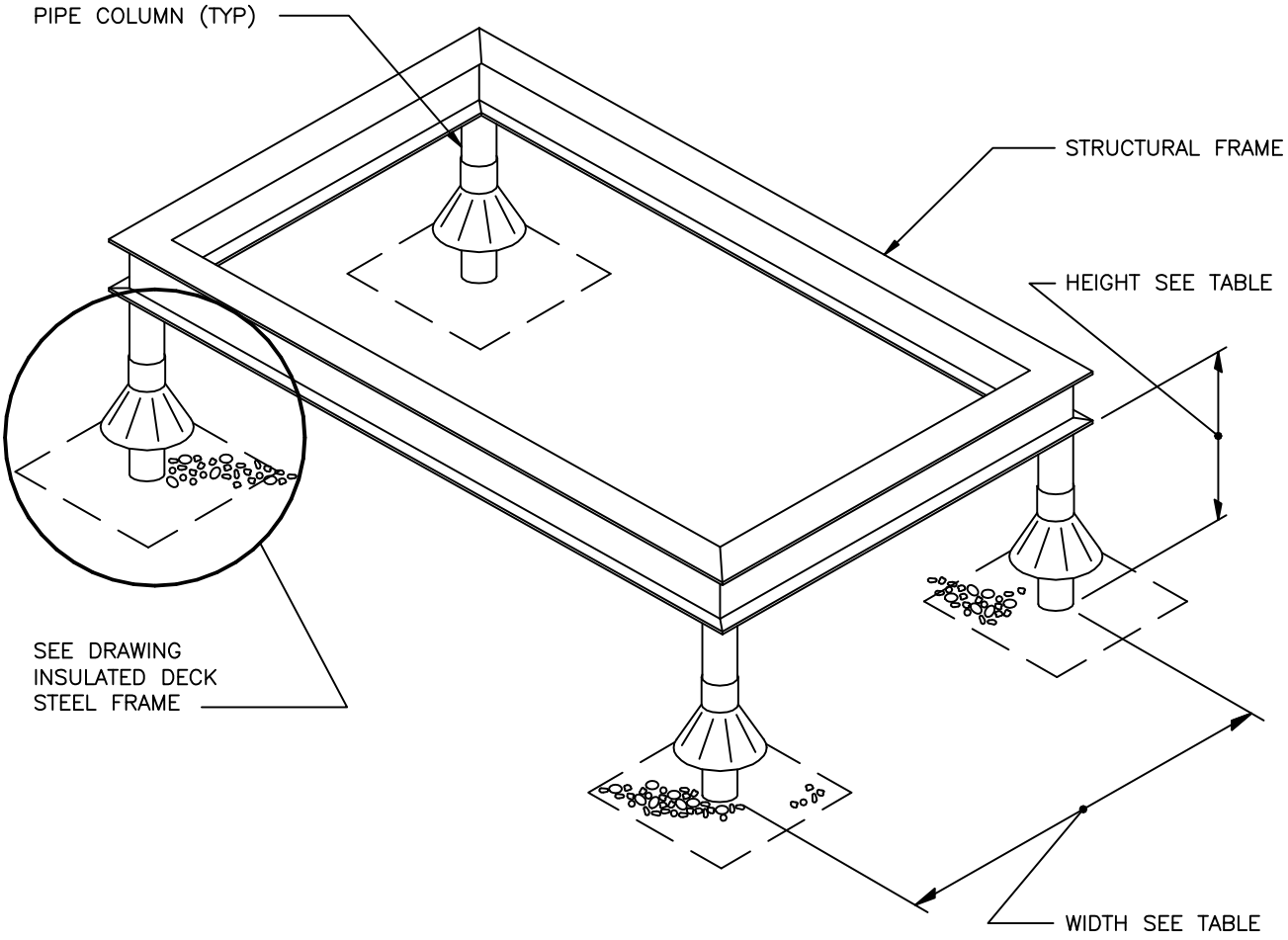

WIDTH OF EQUIPMENT	HEIGHT OF LEGS
UP TO 24"	14"
25" TO 36"	18"
37" TO 48"	24"
49" TO 60"	30"
61" AND WIDER	48"

NOTE :

THIS DETAIL IS PREFERABLE WHEN THE CONCENTRATED LOAD CAN BE LOCATED DIRECTLY OVER COLUMNS OR HEAVY GIRDERS IN THE STRUCTURE OF THE BUILDING. THIS DETAIL CAN BE ADAPTED FOR OTHER USES, SUCH AS SIGN SUPPORTS.

SD–A–15

Mechanical Equipment Stand

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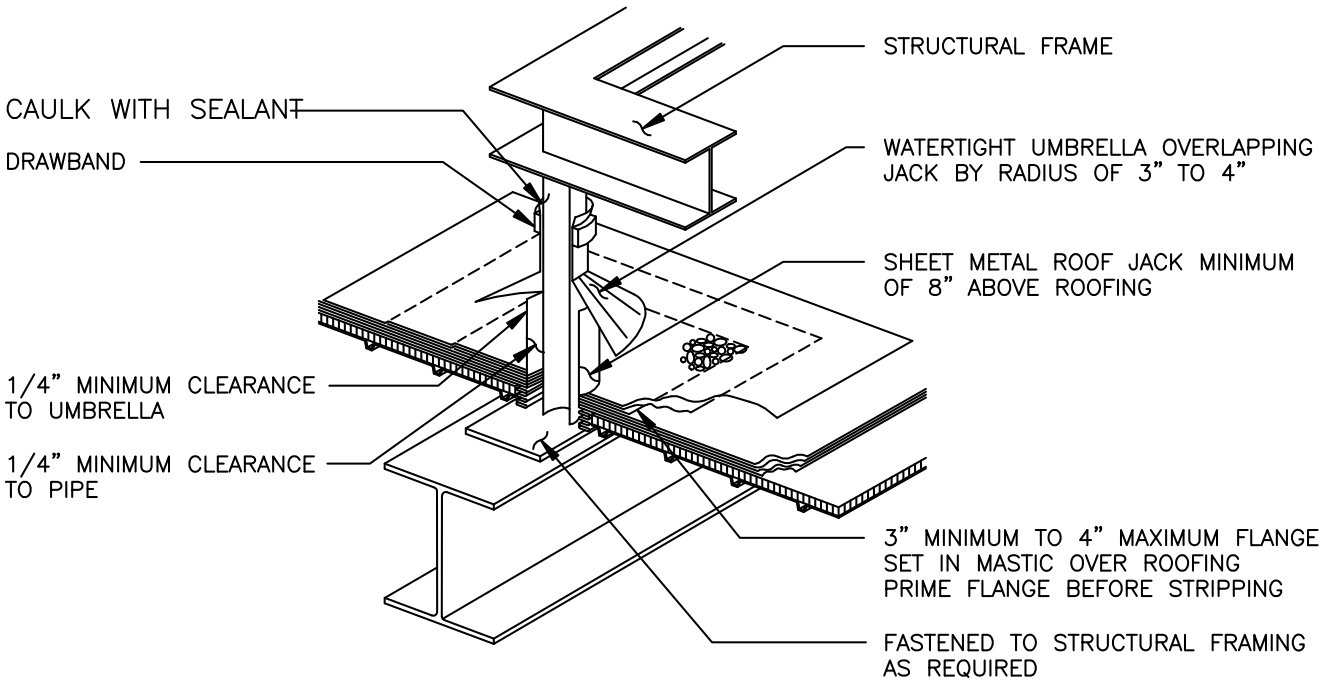

NOTE:

THE DETAILS IN THIS DRAWING DEPICT JOB–SITE FABRICATED CONSTRUCTION MANY MANUFACTURERS NOW OFFER PRE–FABRICATED FLASHING PIECES OR PERMIT THE USE OF MATERIALS FOR FLASHING PURPOSES OTHER THAN THOSE THAT ARE SHOWN HERE SPECIFICS ON THESE PROPRIETARY DESIGNS VARY GREATLY AND INDIVIDUAL MANUFACTURERS SPECIFICATIONS SHOULD BE CONSULTED FOR THEIR USE.

SD–A–16

Insulated Deck Steel Frame

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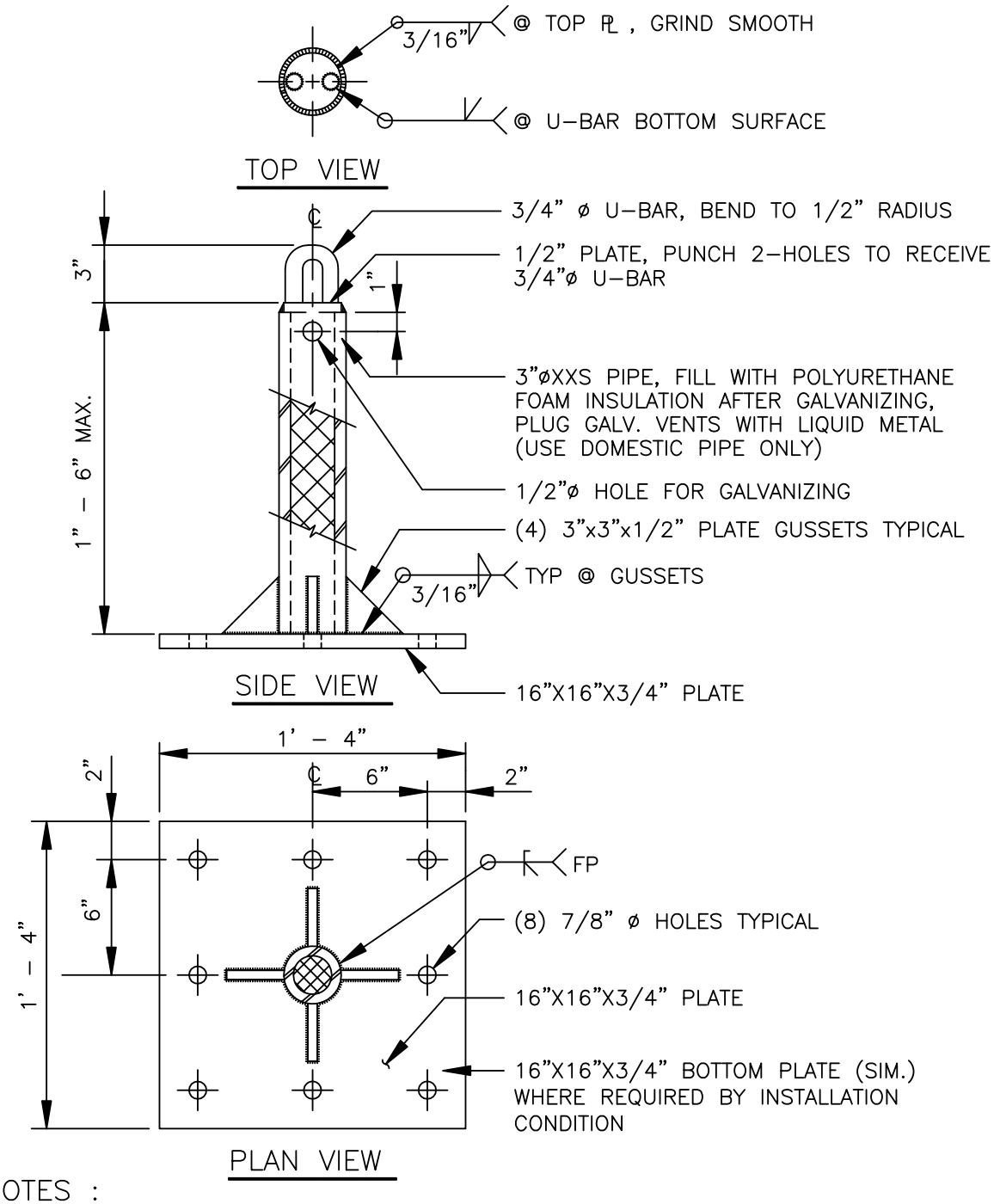

NOTES :

1. GALVANIZED ASSEMBLY AFTER FABRICATION
2. SEE ADDITIONAL DETAILS FOR INSTALLATION, FOR MEMBRANE & FLASHING CONDITIONS
3. ALL STEEL PLATES TO BE TYPE A572 GRADE 50
4. A325 BOLTS TO BE Fu = 120 KSI AND A307 BOLTS TO BE Fu 120 KSI

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Typical Fall Arrest Anchor Fabrication Detail

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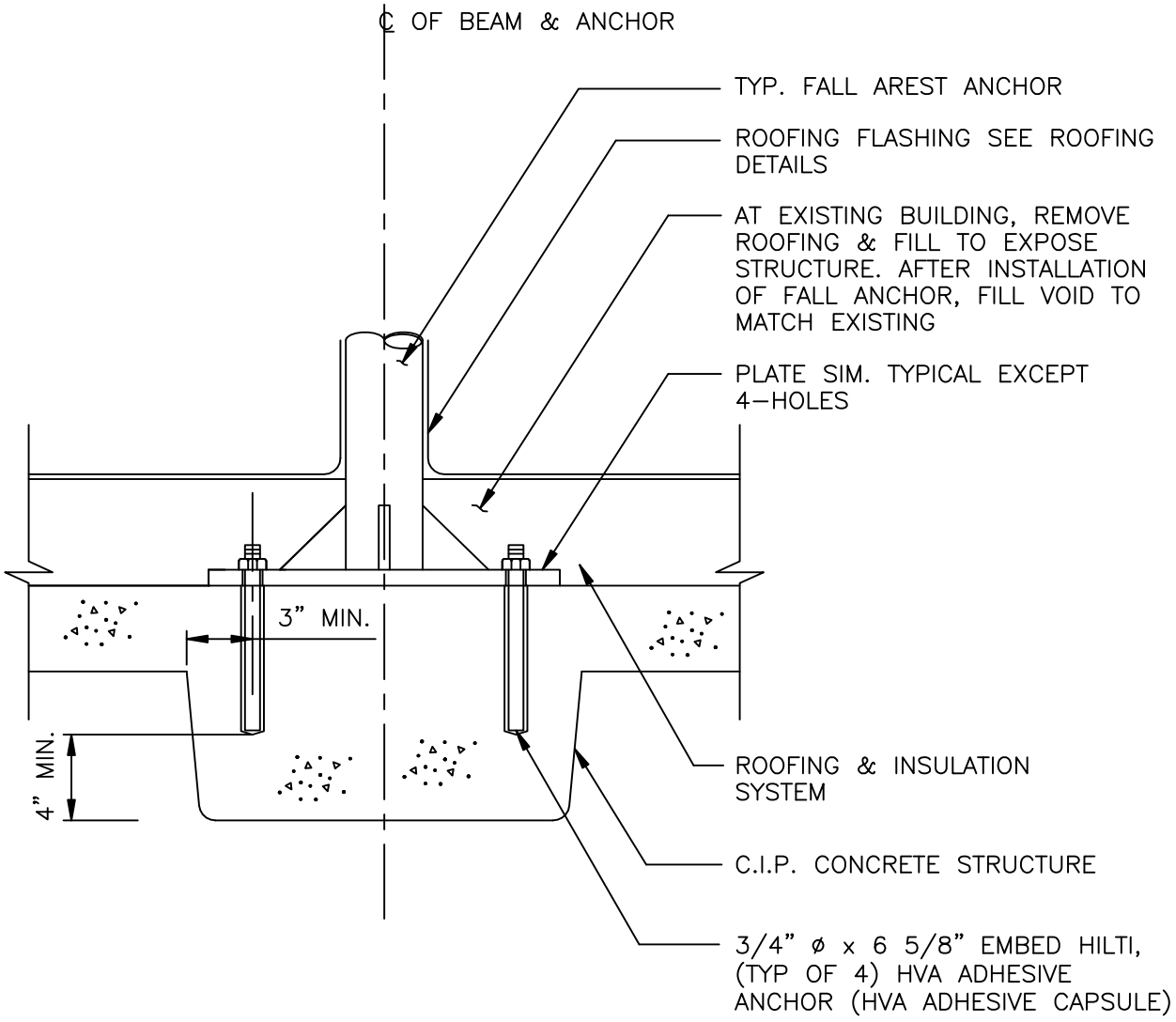

NOTES :

1. DO NOT USE THIS DETAIL WHERE STRUCTURE CONDITIONS VERY FROM THOSE SHOWN
2. VERIFY STRUCTURE IS CAPABLE OF SUPPORTING WORKING LOADS

SD–A–42

Fall Arrest Anchor Installation Detail at Concrete Beam

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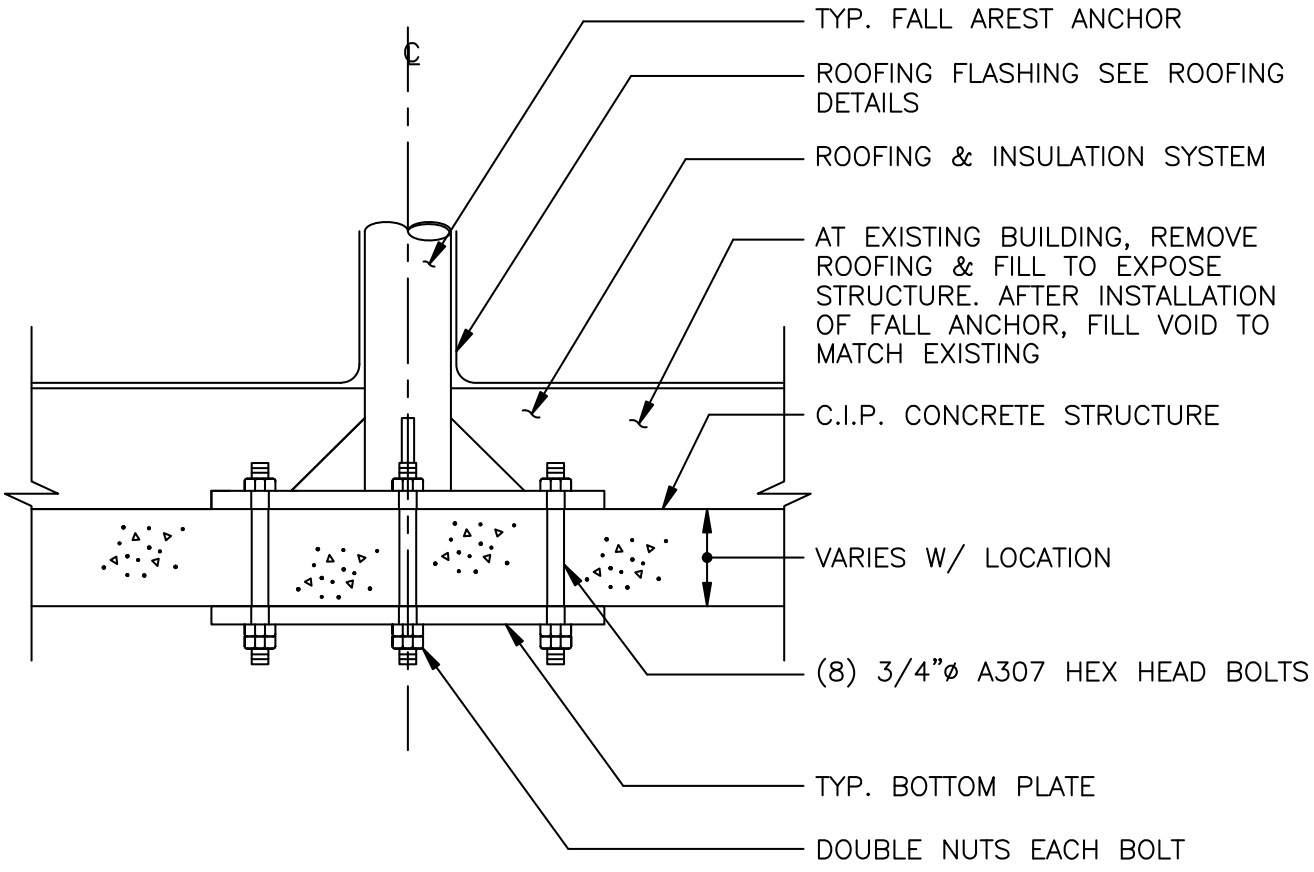

NOTES:

1. DO NOT USE THIS DETAIL WHERE STRUCTURE CONDITIONS VERY FROM THOSE SHOWN
2. VERIFY STRUCTURE IS CAPABLE OF SUPPORTING WORKING LOADS

SD–A–43

Fall Arrest Anchor Installation Detail at Concrete Slab

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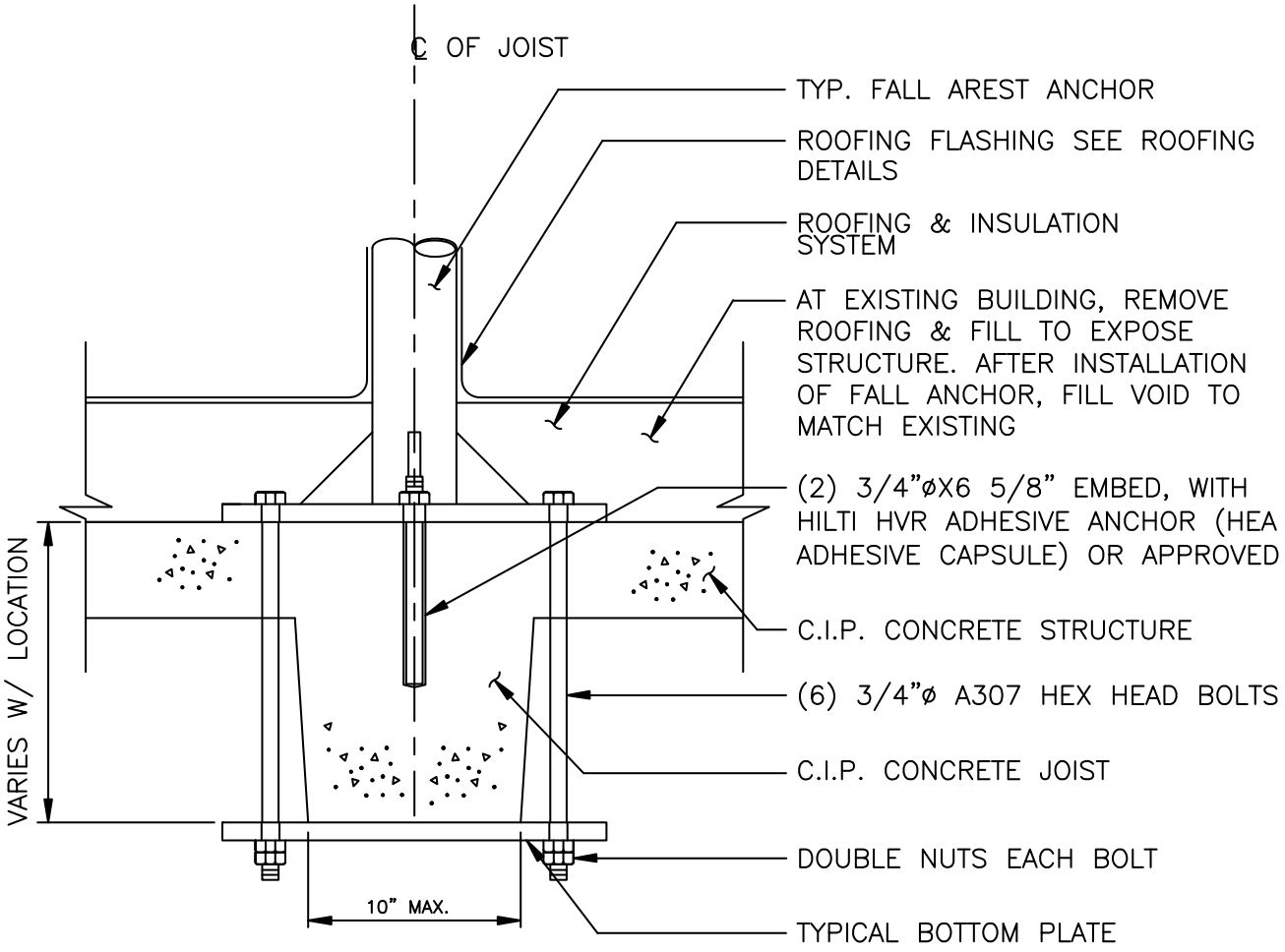

NOTES :

1. DO NOT USE THIS DETAIL WHERE STRUCTURE CONDITIONS VERY FROM THOSE SHOWN
2. VERIFY STRUCTURE IS CAPABLE OF SUPPORTING WORKING LOADS

SD–A–44

Fall Arrest Anchor Installation Detail at Concrete Joist

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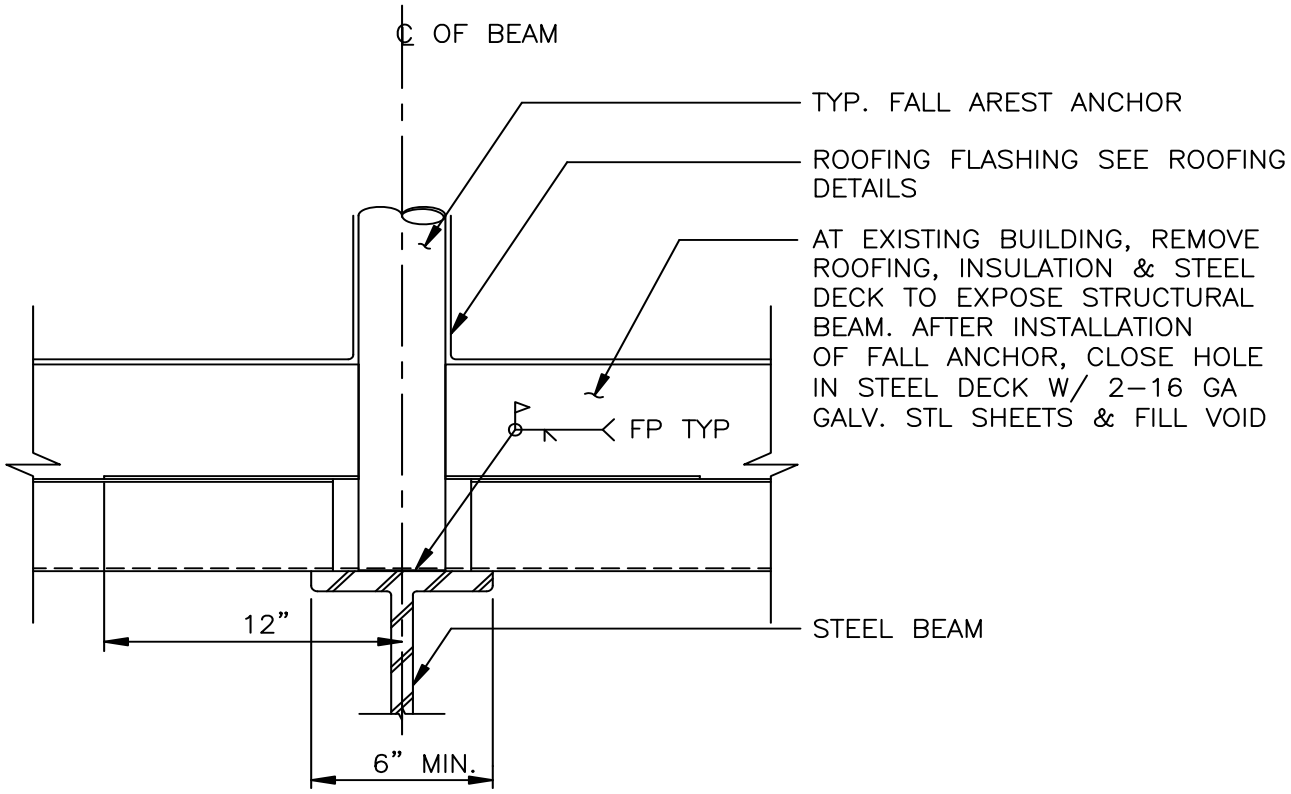

NOTES :

1. DO NOT USE THIS DETAIL WHERE STRUCTURE CONDITIONS VERY FROM THOSE SHOWN
2. VERIFY STRUCTURE IS CAPABLE OF SUPPORTING WORKING LOADS

SD–A–45

Fall Arrest Anchor Installation Detail at Steel Beam

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