

**SECTION 07 51 00  
BUILT-UP BITUMINOUS ROOFING**

**PART 1 GENERAL**

**1.1 DESCRIPTION**

- A. This section includes bituminous built-up roofing, aggregate surfacing, with base flashing for repairs and alterations to existing construction as required for installation of rooftop HVAC equipment.

**1.2 RELATED WORK**

- A. Section 23 44 00, HVAC FANS
- B. Section 23 74 17, PACKAGE MODULAR CONTROL STATION AIR HANDLING UNIT.

**1.3 APPLICABLE PUBLICATIONS**

- A. Applicable publications listed below form a part of this Specification as referenced. Publications are referenced in the text by the number designation only.
- B. American Society for Testing and Materials (ASTM):
  - A167-09 ..... Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
  - B209-07 ..... Aluminum and Aluminum-Alloy Sheet and Plate
  - D41-11 ..... Asphalt Primer Used in Roofing, Dampproofing and Waterproofing
  - D43-00(R2006) ..... Coal Tar Primer Used in Roofing, Dampproofing and Waterproofing
  - D227-03 ..... Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing
  - D312-00(R2006) ..... Asphalt Used in Roofing
  - D448-08 ..... Sizes of Aggregate for Road and Bridge Construction
  - D450-07 ..... Coal-Tar Pitch Used in Roofing, Dampproofing and Waterproofing
  - D751-06 ..... Test Methods for Coated Fabrics
  - D1863-05 ..... Mineral Aggregate Used on Built-Up Roofs
  - D2178-04 ..... Asphalt Glass Felt Used in Roofing and Waterproofing
  - D3884-09 ..... Abrasion Resistance of Textile Fabrics (Rotary Platform Double-Head Method)
  - D3909-97(R2004) ..... Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules

- D4586-07 ..... Asphalt Roof Cement, Asbestos Free
- D4601-04 ..... Asphalt Coated Fiberglass Base Sheet Used In Roofing
- D4897-01(2009) ..... Asphalt Coated Glass Fiber Venting Base Sheet Used in Roofing
- D6163-00(2008) ..... Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
- F1667-11 ..... Driven Fasteners: Nails, Spikes, Staples
- C. FM Global (FMG):
  - P7825C-05 ..... Approval Guide Building Materials (Roofing Products)
  - 4450: ..... Approved Standard for Class 1 Insulated Steel Deck Roofs
  - 4470: ..... Approved Standard for Class 1 Roof Coverings
- D. National Roofing Contractors Association (NRCA):
  1. "Quality Control Guidelines for the Application of Built-up Roofing."
  2. "The NRCA Roofing and Waterproofing Manual"

**1.4 WARRANTY**

- A. Roofing system is subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period is extended to five years.

**1.5 QUALITY CONTROL**

- A. Applicator Qualifications: Installer experienced in installation of systems similar in complexity to that required for this Project, including specific requirements indicated:
  1. Work shall be performed by installer approved in writing by roofing material manufacturer.
  2. Work shall comply with printed instructions of the roofing materials manufacturer.
- B. Product/Material Qualifications:
  1. Provide manufacturer's label on each container or certification with each load of bulk bitumen, indicating Flash Point (FP), Finished Blowing Temperature (FBT), Softening Point (SP), Equiviscous Temperature (EVT).
  2. Provide manufacturer's certification that field applied bituminous coatings and mastics, and field applied roof coatings comply with limits for Volatile Organic Compounds (VOC) per the National Volatile Organic Compound Emission Standards for Architectural Coatings pursuant to Section 183(e) of the Clean Air Act with limits as follows:
    - a. Bituminous Coatings and Mastics: 500 g/l (4.2#/gal.).

- b. Roof Coatings: 250 g/l (2.1#/gal.).
  3. Obtain products from single manufacturer or from sources recommended by manufacturer for use with roofing system.
- C. Comply with the recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to built-up roofing for storage, handling and installation.
- D. FMG Listing: Provide roofing membrane, base flashing, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system and that are listed in FMG "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.

## 1.6 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data:
  1. Asphalt materials, each type.
  2. Coal-tar materials, each type.
  3. Roofing cement, each type.
  4. Fastening requirements.
- C. Certificates:
  1. Indicate materials and method of application of roofing system meet requirements of FMG.
  2. Statements of qualification for manufacturers and installers.
  3. Inspection Report: Copy of roofing system manufacturer's inspection report certifying completed roofing complies with manufacturer's warranty requirements.
- D. Warranty: As specified in Part 1 of this Section:
  1. Warranty sample form with specific language to address Contract provisions.
- E. Contract Close-out Submittals:
  1. Maintenance Manuals.
  2. Warranty signed by installer and manufacturer.

## 1.7 DELIVERY, STORAGE AND MARKING

- A. Deliver roofing materials to the site in original sealed packages or containers marked with the name and brand or trademark of the manufacturer or seller.
- B. Keep roofing materials dry and store in a dry, weather-tight facility or under canvas covers. Do not use polyethylene or plastic covers to protect materials. Store above ground or deck level on wood pallets. Cover ground under pallet stored materials with plastic.

1. Store rolled materials (felts, base sheets, and paper) on end. Do not store hems on top of rolled materials.
  2. Aggregates shall be maintained surface dry as defined by ASTM D1863.
- C. Protect from damage due to handling, weather and construction operations before, during and after installation.

## **1.8 ENVIRONMENTAL REQUIREMENTS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Protection of interior spaces: Refer to Section 01 00 00, GENERAL REQUIREMENTS.

## **PART 2 – PRODUCTS**

### **2.1 ROOFING SYSTEM**

- A. Install built-up roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations of NRCA "Quality Control Guidelines for the Application of Built-up Roofing."
- B. Glass sheet, asphalt bitumen, mineral surfaced.
1. Substrate: Plywood.
  2. Components: Quantity.
    - a. Base Sheet: 1 Ply
    - b. Ply Sheet: 2 Plies
    - c. Mineral Surfaced Cap Sheet: 1 Ply
    - d. Asphalt On Base Sheet 10-17.5 kg/10 sq. meters (20-35 lbs/100 sq. ft.)
    - e. Asphalt Between Each Ply 10-17.5 kg/10 sq. meters (20-35 lbs/100 sq. ft.)
  3. Substrate: Roof Insulation.
  4. Components: Quantity
    - a. Ventilating Base Sheet: 1 Ply
    - b. Ply Sheet: 2 Plies
    - c. Mineral Surfaced Cap Sheet: 1 Ply
    - d. Asphalt Between Substrate, First Ply: 10-17.5 kg/10 sq. meters 20-35 lbs/100 sq. ft.
    - e. Asphalt Between Each Ply 10-17.5 kg/10 sq. meters 20-35 lbs/100 sq. ft.

5. Provide asphalt quantities within the indicated ranges, unless recommended otherwise in the roofing materials manufacturer's printed data.

## 2.2 MATERIALS

- A. Primer: ASTM D41.
- B. Base Sheet: ASTM D4601, Type II, nonperforated, asphalt-impregnated and coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
- C. Venting Base Sheet: ASTM D4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.
- D. Asphalt: ASTM D312, Type III or IV for roof membrane. Use Type I for pour coat unless specified otherwise.
- E. Ply Sheet/Backer Sheet: ASTM D2178, Type VI, heavy-duty ply sheet.
- F. Cap Sheet: ASTM D3909, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.
- G. Roof Cement: ASTM D4586, Type I.
- H. Flashing Sheet: ASTM D6163, Type I or II, glass-fiber-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified.

## 2.3 COAL-TAR MATERIALS

- A. Primer: ASTM D43.
- B. Organic Felt: ASTM D227, except bitumen shall be low fuming, non-blooming type.
- C. Coal-Tar Bitumen: ASTM D450, Type III.
- D. Roof Cement: Roofing manufacturer's standard, asbestos free.

## 2.4 MISCELLANEOUS MATERIALS

- A. Aggregate:
  1. ASTM D1863, except the use of crushed stone is prohibited.
  2. Slag or gravel. Use slag on slopes over 1:10 (one inch per foot).
- B. Roof Walkway:
  1. Prefabricated asphalt plank consisting of a homogeneous core of asphalt, plasticizer and inert fillers, bonded by heat and pressure between two saturated and coated sheets of felt:
    - a. Topside of plank surfaced with ceramic granules.
    - b. Size: Minimum 13 mm (1/2-inch) thick, manufactures standard size, but not less than 300 mm (12 inches) in least dimension and 600 mm (24 inches) in length.

## 2.5 FASTENERS

- A. Nails and Staples: ASTM F1667.
- B. Nails for Securing built-up Flashing and Base Sheets to Wood Nailers and Deck:
  - 1. Zinc coated steel roofing nails with minimum head diameter of 10 mm (3/8-inch) through metal discs at least 25 mm (one inch) across.
  - 2. One-piece nails with an integral flat cap at least 24 mm (15/16-inch) across.
- C. Fasteners for Securing Dry Felt Edge Strips to Wood Nailer and Decks:
  - 1. Zinc coated steel roofing nails, 16-mm (5/8-inch) minimum head diameter.
  - 2. Staples, Flat top Crown, zinc coated may be used.
- D. Nails for Plywood:
  - 1. Use annular thread type at least 19 mm (3/4-inch) penetration of plywood.
  - 2. 16 mm (5/8-inch) minimum head diameter.
  - 3. Nails with flat cap at least 24 mm (15/16-inch) across.
- E. Fasteners and washers required for securing pavers together with straps and to walls or other anchorage.
  - 1. Straps for securing pavers together:
    - a. Stainless steel strap: ASTM A167, type 302 or 304, minimum 0.46 mm (0.018 inch) thick.
    - b. Aluminum strap: ASTM B209, minimum 2.39 mm (0.094 inch) thick.
    - c. Rounded corners on straps.
    - d. Form straps 38 mm (1 1/2 inches) wide, 3 m (10 feet) maximum length with 6 by 10 mm (1/4 by 3/8 inch) punched slotted holes at 100 mm (4 inch centers centered on width of strap. Punch hole size 2 mm (1/16 inch) larger than fastener shank when shank is thicker than 5 mm (3/16 inch).
- F. Fasteners or Connectors for Pavers:
  - 1. For NCMA Roofcap Pavers extruded interlocking hollow shape polyethylene connector: Jinotega31
    - a. Material shall conform to ASTM D1248, Type 1, low density, Class C, black weather resistant, Grade E6, tensile strength 15 Mpa (2200 psi), shore D hardness of 4, brittleness low temperature - 82°C (180°F), softening temperature above 80°C (176°F).

- b. Length: 50 mm (2 inches), with center stop and insert leg with ribs to resist withdrawal; minimum 1.3 mm (0.05 inch) thick.
2. Fasteners for pavers straps:
  - a. Stainless steel as recommended by manufacturer of paver in which fastener is anchored.
  - b. Fasteners that are not acceptable include:
    - 1) Impact or power actuated fasteners.
    - 2) Fasteners that do not require a predrilled pilot hole.
    - 3) Fasteners with lead or white metal anchors.
    - 4) Plastic anchors not stabilized against ultraviolet light.

## 2.6 PROTECTION MAT OR SEPARATION SHEETS

### A. Protection Mat:

1. Water pervious; either woven or non-woven pervious sheet of long chain polymeric filaments or yarns such as polypropylene, black polyethylene, polyester, or polyamide; or, polyvinylidene-chloride formed into a pattern with distinct and measurable openings.
2. Filter fabric equivalent opening size (EOS): Not finer than the U.S.A. Standard Sieve Number 120 and not coarser than the U.S.A. Standard Sieve Number 100. EOS is defined as the number of the U.S.A. Standard Sieve having openings closest in size to the filter cloth openings.
3. Edges of fabric selvaged or otherwise finished to prevent raveling.
4. Abrasion resistance:
  - a. Abrade in conformance with ASTM D3884 using rubber-hose abrasive wheels with one kg load per wheel and 1000 revolutions.
  - b. Result; 25 kg (55 pounds) minimum in any principle direction.
5. Puncture strength:
  - a. ASTM D751 - tension testing machine with ring clamp; steel ball replaced with a 8 mm (5/16 inch) diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.
  - b. Result; 57 kg (125 pounds) minimum.
6. Non-degrading under a wet or humid condition within minimum 4°C (40°F) to maximum 66°C (150°F) when exposed to ultraviolet light.
7. Minimum sheet width: 2400 mm (8 feet).

## **PART 3 – EXECUTION**

### **3.1 GENERAL**

- A. Do not apply if deck will be used for subsequent work platform, storage of materials, or staging or scaffolding will be erected thereon.
- B. Phased construction is not permitted. The complete installation of roofing system is required in the same day except for area where temporary protection is required when work is stopped. Complete installation includes pavers and ballast for ballasted systems.

### **3.2 EXAMINATION**

- A. Verification of Conditions: Examine substrates, areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion:
  - 1. Do not proceed until unsatisfactory conditions, including moisture, have been corrected.
  - 2. Do not install roofing materials over wet insulation.
  - 3. Do not install roofing materials unless roof openings, wood nailers, edge venting, insulation board, flashing, curbs, and roof joints are constructed.
  - 4. Do not install roof materials unless deck and/or insulation provides designed drainage to working drains.
- B. Uninsulated Concrete Decks, except Insulating Concrete:
  - 1. Test deck for moisture prior to application of roofing materials.
  - 2. Test by pouring one pint of hot bitumen at 204 degrees C (400 degrees F.) or EVT on deck at start of each day's Work and at start of each new roof area or plane. Do not proceed if test sample foams or can be easily (cleanly) stripped after cooling.
- C. Insulating Concrete: Allow deck to dry before installing materials.
- D. Do not apply roof system if roofed deck will be used as a work platform.
- E. Existing Intake Louvers:
  - 1. Use large fans during placement to direct airflow away from existing intake louvers.
  - 2. If required to install roof near intake louvers after work hours, it shall be done so without additional cost to the Government.

### **3.3 PREPARATION**

- A. Sweep substrate to broom clean condition. Remove all dust, dirt and debris.
- B. Remove surface irregularities that may damage materials or cause installation defects.
- C. Coordinate operations with roof insulation and sheet metal work to permit continuous roofing operations.

### 3.4 INSTALLATION

- A. Comply with roofing system manufacturer's written instructions and applicable recommendations of NRCA "Quality Control Guidelines for the Application of Built-up Roofing."
- B. Cooperate with inspection and test agencies required to perform services in connection with built-up roofing system installation.
- C. General:
  - 1. Provide uniform and positive adhesion between all installed materials, including adhesion to insulation or substrate, and between each ply of felt.
  - 2. Substrate Penetrations: Do not allow bitumen to penetrate joints or enter building. Where mopping is applied directly to a substrate, tape joints. When applying steep asphalt, hold mopping back 50mm (2 inches) from each side of joint.
- D. Asphalt Products Schedule:
  - 1. Use asphalt only with asphalt-saturated or asphalt-impregnated felts.
  - 2. Use Type I asphalt for pour coats up to 1:10 (one inch per foot) slope.
  - 3. Coats on slopes over 1:10 (one inch per foot).
  - 4. Use asphalt roof cement with asphalt products.
- E. Bitumen Schedule:
  - 1. Per square, unless otherwise specified.
  - 2. Between substrate and plies of organic felt:
    - a. Asphalt 7 to 11 Kg (15 to 25 pounds).
  - 3. Between substrate and plies of glass fiber felts asphalt, 9 to 14 kg (20 to 30 pounds).
  - 4. Glaze Coats:
    - a. Asphalt 7 to 11 Kg (15 to 25 pounds).
  - 5. Pour coats:
    - a. Asphalt 25 to 30 Kg (55 to 65 pounds).
  - 6.
- F. Heating Bitumen:
  - 1. Heat the asphalt to the equiviscous temperature (EVT) plus or minus 4 C (25 degrees F) at the time of application.
    - a. Do not heat asphalt greater than 38 C (100 degrees F) above the EVT.
    - b. When the EVT is not furnished do not heat asphalt above 246 C (475 degrees F) for Type I and 275 C (525 degrees)

F for Type II and IV, with an application not less than 218 C (425 degrees F) and 246 C (475 degrees F) respectively.

2. Do not heat bitumen above the flash point temperature.
3. Provide heating kettles with a thermometer kept in operating condition. Attend, during heating, to insure the bitumen is heated within the temperatures specified.
4. Do not mix different types of bitumen in kettle.

G. Terminations:

1. Where cants occur at vertical surfaces, cut off plies of membrane 50mm (2 inches) above top of cant strip, (except at prefabricated curbs, scuttles and other roof accessories having integral cants) extend membrane over cant and up vertical surface to top of curb or blocking.
2. Where wood blocking occurs at roof edge, under gravel stops or penetrations to receive base flashing, nail a continuous strip of 400 mm (16-inch) wide, loose applied organic felt envelope over the blocking before the first ply sheet is applied.
  - a. Install strip on top of venting base sheet.
  - b. After membrane is installed, turn the dry felt back over the roofing and secure in place with hot bitumen before gravel stops or metal flanges extending onto the membrane are installed.
3. Where fascia/cant occurs at roof edges, extend membrane beyond outside face and cut off after base flashing is installed.

H. Base Sheet:

1. One ply of base sheet dry to deck, except mop between laps. Lap and attach as specified to deck.

I. Venting Base Sheet:

1. At vertical surfaces: Extend venting base sheet up vertical surface over cants to top of base flashing or curb.
2. At roof edge under gravel stops install venting base sheet over blocking: Extend base sheet not less than 50 mm (2-inches) beyond outer edge and turn down to allow venting at the edge.
3. At roof edge over fascia-cant: Extend base sheet over top of cant and turn down over outer face of cant to allow venting at the edge.

J. Roof Ply Installation:

1. Install, asphalt, glass fiber felt construction. Base sheet is not considered a ply.
2. Extend the first ply 100 mm (4-inches) beyond the insulation and the second ply 75 mm (3-inches) beyond the first. Lap ends 75 mm (3-inches) with joints broken 450 mm (18-inches) in each ply.

- K. Laps for felts and base sheet:
1. Base sheet, lapped 50 mm (2-inches).
  2. Three plies of felt with 300 mm (12-inches) 600 mm (24-inches) and 900 mm (36-inch) starting widths, lapped 624 mm (24-1/2 inches).
  3. End joints of felt and base sheet, lapped 50 mm (2-inches). Stagger end joints in relation to joints in adjacent and proceeding plies.
- L. Flashing:
1. Prime vertical surfaces of masonry and concrete with asphalt primer except where vented base sheet is required to provide edge venting.
  2. Apply flashing on top of built-up roofing, up face of cant and vertical surfaces, at least 200 mm (8-inches) above the roof, full height beneath counter flashing or top of curb flashing:
    - a. At fascia-cants, extend to top of cant and cut off.
  3. Except at metal fascia cants, secure top edge of base flashing with nails on a line approximately one inch below top edge, spaced not more than 200 mm (8-inches) on center.
    - a. Cover all nail heads with roof cement.
    - b. Cover the top of the base flashing with counter flashing as specified in Section 07 60 00, FLASHING AND SHEET METAL. At the cants secure the top edge of the flashing with fascia compression clamp as specified in Section 07 60 00, FLASHING AND SHEET METAL.
  4. Install flashing using longest pieces practicable. Complete splices between flashing and main roof sheet before bonding to vertical surface. Seal splice not less than 76mm (3-inches) beyond fasteners that attach membrane to blocking. Apply bonding adhesive to both flashing and surface to which flashing is being adhered per manufacturer recommendations. Nail top of flashing 300mm (12-inches) on center under metal counter flashing or cap.
    - a. Parapet Walls: Extend up parapet and turn over top edge. Apply with 100 percent adhesive.
  5. Install flashing over cants to make system watertight.
  6. Install flashing before final roofing coat and aggregate are installed.
- M. Stripping:
1. Set flanges of metal flashing in roof cement before the final bituminous coat and roof aggregate are installed and nail to blocking per Section 07 60 00, FLASHING AND SHEET METAL.
  2. Before the final bituminous coat and aggregate are installed, cover that portion of the horizontal flanges of metal base flashing, gravel

stops and other flanges, extending onto the roofing with flashing sheet consisting of two plies of organic felt with coal tar bitumen.

N. Aggregate Surfacing:

1. After bituminous base flashing and stripping has been installed, uniformly coat the entire roof surface, except cants, with bitumen pour coat at the rate scheduled.
2. Use type III asphalt on slopes over 1:10 (one inch per foot).
3. While still hot, embed aggregate to cover the roofing sheet completely without bare spots, but not less than 20 Kg/m<sup>2</sup> (400 pounds/) of dry gravel or 15 Kg/m<sup>2</sup> (300 pounds/100 square feet) of dry slag per. Do not leave any exposed bitumen.
4. Do not embed aggregate under roof walkways.
5. In cold weather preheat aggregate prior to application.
6. Do not place aggregate material in piles or rows on bare or glaze coated felt.
7. If aggregate surfacing is delayed, promptly apply glaze coat of hot roofing asphalt at rate scheduled.

O. Roof Walkways:

1. Install roof walkways where shown.
2. Prefabricated asphalt plank: sweep away loose roof aggregate from area to receive plank. Set planks in hot bitumen poured over the firmly embedded roof aggregate as specified for pour coat. Maintain minimum 75-mm (3-inches) to maximum of 150 mm (6-inches) space between planks.

### 3.5 REPAIR AND ALTERATIONS TO EXISTING ROOF

- A. Areas to be altered or repaired, remove loose aggregate and aggregate not firmly embedded where new penetrations occur or repairs are required:
1. Remove aggregate 900 mm (3 feet) beyond areas to be cut.
    - a. Clean, dry and store aggregate away from roof area until ready to reuse.
    - b. Remove unsuitable and excess aggregate not used from Project.
- B. Cut and remove existing roof membrane for new work to be installed. Clean cut edges and install a temporary seal to cut surfaces. Use roof cement and one layer of 7 Kg (15 pound) felt strip cut to extend 150 mm (6 inches) on each side of cut surface. Bed strip in roof cement and cover with roof cement to completely embed the felt.
- C. Bend up cap flashing or temporarily remove at built-up base flashing to be repaired. Brush and scrape away deteriorated and loose bitumen, felts or surface material of built-up base flashing.
- D. Repairs to existing membrane and base flashing:

1. Remove temporary patches prior to starting new work.
2. Blisters and fish mouths:
  - a. Cut blisters open and turn membrane back to fully adhered portion. Cut fish mouths so membrane can be turned back and subsequently laid flat.
  - b. Heat membrane to facilitate bending and to dry surface of exposed blister areas.
  - c. Mop turned back membrane in hot bitumen. Roll to insure full adhesion and embedment in substrate.
  - d. Cover cut areas with two plies of felt. Extend first ply 100 mm (4-inches) beyond cut area edge. Extend second 100 mm (4 inches) beyond first ply. Mop down in hot bitumen as specified for new work. Resurface to match existing.
3. Exposed Felts:
  - a. Cut away exposed deteriorated edges of sheets.
  - b. Glaze coat felt edges.
  - c. Resurface to match existing.
4. Built-up Base Flashing:
  - a. Restore felts and cap sheet removed, lapping 100 mm (4-inches) over existing.
  - b. Install new felts and cap sheet as specified for new work.
5. Horizontal Metal Flanges:
  - a. Remove loose, buckled or torn stripping.
  - b. Remove loose fasteners and install new fasteners.
  - c. Restrip flanges as specified for new work.
6. Resurfacing:
  - a. Over repaired membrane, embed aggregate as specified for new work.
  - b. Cover all membrane areas. Do not leave any exposed membrane surface.
- E. Match existing roofing materials and construction. Use bitumen compatible with existing for roof repair and alteration.
- F. Perform alterations, maintenance and repairs to roof membrane immediately after membrane has been cut or damaged, with permanent new work as specified in this specification. Repair items damaged in surface preparation and aggregate removal.

### **3.6 INSTALLATION OF BALLAST SYSTEM AND PAVERS**

- A. Install as soon as roof membrane is laid.
- B. Protective underpayment installation under ballast:

1. Loose lay protection mat or separation sheet over roof membrane smooth and free of tension and stress without wrinkles. Do not stretch sheet.
  2. Use full sheet width at perimeters with end laps held back not less than 3 m (10 feet) from roof edge at corners.
  3. Lap ends not less than 300 mm (one foot).
  4. Extend 50 to 75 mm (2 to 3 inches) above ballast at perimeter and penetrations.
- C. Pavers may be substituted for aggregate over entire roof area.
1. Paver weight equal to aggregate weight unless interlocking or strapped together and clamped down at roof edge.
  2. Interlocking pavers as required for wind exposure conditions and fire protection.
- 3.7 Installation of pavers:
- A. Saw cut or core drill pavers for cut units.
- B. Install pavers with butt joints in running bond with not less than one half length units at ends.
1. Stagger end joints; generally locate joints near midpoint of adjacent rows, except where end joints occur in valleys. Miter end joints to fit in valleys.
  2. Cut to fit within 13 mm (1/2 inch) of penetrations.
  3. Install interlocking connectors in channel units for complete tie in of units, including cut units. Use corner spacings for a distance of 1200 mm (4 feet) or more around roof drains, penetrations, and other vertical surfaces in the field of the roof area.
  4. Install strapping where shown.
    - a. Limit strap lengths to a maximum of 9 m (30 feet).
    - b. Install straps at corner connection to the perimeter retainer at approximate 45 degree angle at approximate 3 to 3.6 m (10 to 12 feet) from corner.
    - c. Install straps on each side of the valleys, hips, and ridges, with cross straps spaced not over 1200 mm (4 feet) on center between the end straps.
    - d. Install straps at the perimeter of the penetrations more than two paves in width or length.
    - e. Anchor straps to each paver with two fasteners per unit.
    - f. Pre-drill holes for fasteners in pavers.

**END OF SECTION 07 51 00**