

(C) Cleanliness of Recyclable Ferrous Metallic Abrasives

Shop facilities shall annually acquire a composite sample of their recycled abrasive (work mix) in the Department's presence. A composite sample is a mixture of individual samples taken from a minimum of three separate areas of the work mix. The composite sample is to be tested at an accredited laboratory and provide the Department with a TCLP analysis and sulfate and chloride testing. The shop shall provide annually, the Department with a notarized Type 3 certification certifying the plant location has not used their facilities or equipment for the removal of lead based coatings. Prior to starting work, field contractors recycled work mix used shall meet the requirements of SSPC AB-2 prior to first use for each Department project.

Shop and Field Contractors cleaned work mix shall meet the requirements of SSPC AB-2 and maintain the size and shape of the abrasive to impart the specified profile. The quality control inspector shall document and test the cleaned work mix prior to starting work once every 12 hours or once every work shift whichever period is shorter. Abrasive testing shall meet and be performed in accordance with SSPC AB-2, ASTM D4940 (Water Soluble Contaminants), ASTM D7393 (Oil Content), SSPC PA-17 (Particle Size Distribution) and the Contract documents.

Nonconforming work mix shall not be used, shall be removed from equipment and shall be disposed of in accordance with federal, state, and local regulations and project specification requirements. If non-compliant work mix is detected during continuous recycling following three failing testing attempts blasting and handling equipment shall be checked for residual contamination after removal of the contaminated media. Following cleaning, new compliant media should be fed through the equipment and shall be tested for compliance with requirements of SSPC-AB 2 before production work resumes.

1080-13 FIELD PERFORMANCE AND SERVICE

Do not use paint products inspected by the Engineer and found to exhibit poor performance in similar North Carolina environments. Poor performance is defined as any coating failing to meet ASTM D610, Grade 5, or having greater than 3% rusting or disbonding before attaining 5 years of service.

SECTION 1081 EPOXY AND ADHESIVES

1081-1 EPOXY RESIN SYSTEMS

(A) Classification

The types of epoxies and their uses are as shown below:

Type 1 - A low-modulus, non-sag gel adhesive used to bond or repair damp, vertical or overhead surfaces. Typical applications include walls, concrete foundations, concrete pipe, conduit and ceilings.

Type 2 - A low-modulus, general-purpose adhesive used in epoxy mortar repairs. It may be used to patch spalled, cracked or broken concrete where vibration, shock or expansion and contraction are expected. Feather-edged patching is not recommended with this material; instead, the adjacent concrete perimeter should be sawed at least 1/4 inch to 1/2 inch deep and any remaining concrete chipped away to provide a vertical interface between the epoxy mortar and concrete.

Type 3 - A high-modulus general-purpose adhesive used to bond plastic concrete or hardened concrete to hardened concrete or other structural materials. It may be used to produce a high-strength epoxy mortar grout bed for equipment or to patch interior spalls, cracks or broken concrete. It is not recommended for exterior patching because its rate of thermal expansion and contraction differs too greatly from concrete. It may be used for anchoring bolts where a flowable adhesive is required.

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Type 3A - A gel-like version of Type 3, used specifically for embedding dowel bars, threaded rods, rebars and other fixtures in hardened concrete.

Type 4A - A gray protective coating for concrete, wood, steel and other structural materials. It is typically used as a topcoat in waterproofing concrete exposed to splash zones and tidal water.

Type 4B - A red primer coating used with Type 4A.

Type 5 - A high modulus, low viscosity adhesive suitable for pressure injection into cracks in concrete. For some non-structural crack repairs, Type 5 epoxy may be poured on the surface to penetrate cracks by gravity. This may be beneficial before waterproofing and skid proofing.

(B) Requirements

Epoxies shall conform to the requirements shown in Table 1081-1 using the test methods described in Article 1081-3.

For epoxy resin systems used for embedding dowel bars, threaded rods, rebar, anchor bolts and other fixtures in hardened concrete, the manufacturer shall submit test results showing that the bonding system will obtain 125% of the specified required yield strength of the fixture. Furnish certification that, for the particular bolt grade, diameter and embedment depth required, the anchor system will not fail by adhesive failure and that there is no movement of the anchor bolt. For certification and anchorage, use 3,000 psi as a minimum Portland cement concrete compressive strength used in this test. Use adhesives that meet Section 1081.

List the properties of the adhesive on the container and include density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength.

(C) Properties of Epoxy Resin Systems

(1) All integral fillers, pigments and thixotropic agents shall be fine enough to not separate, settle or cause skinning during storage of the epoxy components. Do not use abrasive fillers such as alumina and silica flour. Do not use solvents. When mineral fillers are to be added during mixing, they shall be inert, readily dispersible and except for sand, have fineness such that 99% of the material will pass a No. 325 sieve.

(2) The coefficient of expansion of cured epoxy is 6 times greater than that of concrete. Therefore, to reduce spalling and peeling during temperature changes, avoid thick layers of pure epoxy. A 4:1 by weight sand-epoxy mortar has approximately the same coefficient of expansion as concrete.

(3) The shelf life of parts A and B shall be at least one year from the date of manufacture.

(4) Types 1 through 5 epoxy resin systems are moisture insensitive and can be applied on clean, dry or damp surfaces free of standing water.

Table 1081-1
Properties of Mixed Epoxy Resin Systems

Property	Type 1	Type 2	Type 3	Type 3A	Type 4A	Type 4B	Type 5
Viscosity-Poises at 77°F ± 2°F	Gel	10-30	25-75	Gel	40-150	40-150	1-6
Spindle No.	-	3	4	--	4	4	2
Speed (RPM)	-	20	20	--	10	10	50
Pot Life (Minutes)	20-50	30-60	20-50	5-50	40-80	40-80	20-60
Minimum Tensile Strength at 7 days (psi)	1,500	2,000	4,000	4,000	1,500	1,500	4,000
Tensile Elongation at 7 days (%)	30 min.	30 min.	2-5	2-5	5-15	5-15	2-5
Min. Compressive Strength of 2" mortar cubes at 24 hours	3,000 (Neat)	4,000-	6,000-	6,000 (Neat)	3,000	3,000	6,000
Min. Compressive Strength of 2" mortar cubes at 7 days	5,000 (Neat)	-	-	-	-	5,000	-
Maximum Water Absorption (%)	1.5	1.0	1.0	1.5	1.0	1.0	1.0
Min. Bond Strength Slant Shear Test at 14 days (psi)	1,500	1,500	2,000	2,000	1,500	1,500	1,500

(D) Test Methods for Epoxies

(1) Viscosity

Determine the viscosity of the mixture in accordance with AASHTO T 237 using Brookfield viscometer model RVT. Use the spindle number and speed shown in Table 1081-1.

(2) Pot Life

Determine the pot life of the mixture in accordance with AASHTO T 237 except use a mass of $60 \pm 0.4\text{g}$.

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(3) Compressive Strength of Epoxy Mortar

Determine the compressive strength of epoxy mortar in accordance with ASTM C109 except as follows:

Use mortar consisting of one part epoxy and 3 parts standard graded Ottawa sand except for Types 1 and 3A, which shall be tested neat. Mix epoxy components A and B at the recommended proportions for 2 minutes, add the sand, and mix for 3 minutes. Pour the mortar into the cube molds in two layers, and tamp each layer 50 times with a spatula and 25 times with a hammer handle. Make six specimens, and cure all in air at $77^{\circ}\text{F} \pm 2^{\circ}\text{F}$ for 24 hours. Test three specimens for compressive strength at the end of this curing period. Immerse the remaining three specimens in water at $+ 77^{\circ}\text{F}$ for 6 days, after which immediately test them for compressive strength in the wet condition.

(4) Tensile Strength and Tensile Elongation

Determine the tensile strength and tensile elongation of the mixture in accordance with ASTM D638.

(5) Absorption

Determine the water absorption of the mixture in accordance with ASTM D570.

(6) Bond Strength

Determine the bond strength of the moist-cured mixture at 14 days by the slant shear test in accordance with ASTM C882.

(E) Prequalification

All epoxy resin systems shall be on the NCDOT Approved Products List before use. Manufacturers choosing to supply material for Department jobs must submit an application through the Value Management Unit with the following information for each type and brand name:

(1) Contact information, including name, address and telephone number of the manufacturer,

(2) Brand/Trade name of the material,

(3) Type of the material in accordance with Article 1081-1 and 1081-4,

(4) Technical data sheet stating at a minimum product description, yield, technical information, mixing directions, finishing directions, curing, clean-up and precautions/limitations,

(5) Material Safety Data Sheets,

(6) Certified test data showing the product meets the specifications, including evidence that the testing laboratory is regularly inspected by the Cement and Concrete Reference Laboratory (CCRL) of the National Institute of Standards Technology or other approved reference laboratory, and

(7) A sample of the product for testing (four injection tubes or 1/2 gallon of each component is required for testing).

Products will remain on the NCDOT Approved Products List as long as the formulation and manufacturing process remain unchanged, and the product performs as intended in the field.

(F) Acceptance

When materials on the NCDOT Approved Products List are furnished to a project, submit to the Engineer a Type 3 material certification in accordance with Article 106-3 for each lot or batch delivered.

When materials are furnished to the Bridge Maintenance Unit, the terms of acceptance will be listed in the bid solicitation. The Engineer reserves the right to reject any epoxy that does not perform adequately in the field.

(G) Supply

Supply epoxy resin in two components, labeled as “Component A - Contains Epoxy Resin” and “Component B - Contains Curing Agent”, for combining immediately before use in accordance with the manufacturer’s instructions. Mark each container with the manufacturer’s name, NCDOT type, lot or batch number, quantity, date of manufacture, shelf life or expiration date, color, mixing instructions, usable temperature range and hazards or safety precautions.

Furnish the two components in separate non-reactive containers. Provide containers of such size that the proportions of the final mix can be obtained by combining a single container of one component with one or more whole containers of the other component.

(H) Notes on Use of Epoxies**(1) Safety**

Epoxies can irritate the eyes, skin and respiratory tract. Therefore, wear chemical splash goggles, chemically-resistant gloves and protective clothing and boots when handling epoxies. Respiratory protection is usually not needed if epoxies are mixed and applied in well-ventilated areas, but avoid prolonged breathing of vapors. Follow all MSDS instructions for proper use of these materials.

(2) Mixing

Stir parts A and B individually until each component is homogeneous. Use a separate stirrer for each component.

Combine parts A and B, either by weight or volume, as specified in the manufacturer’s instructions. Stir the mixture vigorously, periodically scraping the sides and bottom of the container. Small quantities of epoxy usually require 2 to 3 minutes to mix homogeneously; 5-gallon quantities can take up to 10 minutes of mixing.

Temperature affects the viscosity and pot life of epoxies. Most laboratory tests are conducted at 77°F. Higher temperatures render epoxies thinner and faster setting; lower temperatures induce higher viscosities and longer pot lives.

Add sand or other fillers to liquid epoxies only after parts A and B have been thoroughly mixed. Stir in the sand or filler until all particles are completely coated.

(3) Storage and Substrate Temperature

Store epoxies at temperatures between 50°F and 90°F. Epoxy components exposed to the extremes of this range or outside this range should be conditioned to 77°F before mixing and blending. If heat is necessary, always use indirect methods such as hot water, a heated room or a microwave oven to condition components.

When applying epoxy to a cold substrate, preheat the components approximately 1°F above 77°F for every 2°F of substrate temperature below 77°F.

Seal previously opened containers to be airtight. Unsealed containers can absorb moisture from the atmosphere, which can alter the chemical reaction of the mixture.

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1081-2 POLYESTER RESIN EPOXY ADHESIVE

(A) General

Polyester resin is used specifically for embedding dowel bars, threaded rods, rebars and other fixtures in hardened concrete.

Have the manufacturer submit test results showing that the bonding system will obtain 125% of the specified yield strength of the anchor fixture in concrete with a minimum compressive strength of 3,000 psi. Field testing may be required for adhesively anchored fixtures.

(B) Materials

Package components of the adhesive in containers of such size that one whole container of each component is used in mixing one batch of adhesive. Use containers of such design that all of the contents may be readily removed, and are well sealed to prevent leakage. Furnish adhesive material that requires hand mixing in two separate containers designated as Component A and Component B. A self-contained cartridge or capsule will consist of two components which will be automatically mixed as they are dispensed, as in the case of a cartridge, or drilled into, as in the case of a capsule.

Clearly label each container with the manufacturer's name; date of manufacture; batch number; batch expiration date; all directions for use and such warning of precautions concerning the contents as may be required by Federal or State laws and regulations.

(C) Mixing of Adhesive

Mix adhesive in conformance with the manufacturer's instructions.

1081-3 HOT BITUMEN

Mix the adhesive asphaltic material with the filler homogeneously.

(A) Physical Requirements

Supply materials meeting Tables 1081-2 or 1081-3 and 1081-4.

**TABLE 1081-2
ADHESIVE PROPERTIES OF ASPHALTIC MATERIAL WITH FILLER**

Property	Min.	Max.	Test Method
Softening point, °F.	200	-	ASTM D36
Penetration, 100 g, 5 sec., 77°F	10	18	ASTM D5
Flow, inch, as modified in Subarticle 1081-4(B)	-	0.2	ASTM D5329
Viscosity, 400°F, poises or ASTM D4402 as modified in Subarticle 1081-4(B)	30	75	ASTM D2669
Flash Point, C.O.C., °F.	550	-	ASTM D92

**TABLE 1081-3
ASPHALT PROPERTIES OF ASPHALTIC MATERIAL
WITHOUT FILLER**

Property	Min.	Max.	Test Method
Penetration, 100 g, 5 sec., 77°F	25	-	ASTM D5
Viscosity, 275°F poises	12	100	ASTM D2171
Viscosity Ratio, 275°F	-	2.2	See Subarticle 1081-3(B)

**TABLE 1081-4
FILLER PROPERTIES**

Property	Min.	Max.	Test Method
Filler Content, % by Weight	65%	75%	See Subarticle 1081-3(B)
Filler Fineness, % Passing No. 325	75%	-	ASTM C430 as modified in Subarticle 1081-3(B)
Filler Fineness, % Passing No. 200	95%	-	
Filler Fineness, % Passing No. 100	100%	-	

(B) Test Methods

(1) Flow

Determine flow according to Section 6 of ASTM D5329 with the exception that the oven temperature shall be $158^{\circ}\text{F} \pm 2^{\circ}\text{F}$ and sample preparation done according to Section 7.1 of ASTM D5.

(2) Viscosity

Viscosity is to be determined according to ASTM D2669 or ASTM D4402 using a spindle speed of 10 rpm. Heat the adhesive to approximately 410°F and allowed to cool. Determine viscosity at $400^{\circ}\text{F} \pm 1^{\circ}\text{F}$.

(3) Asphalt Properties

Properties of the base asphalt are to be determined on the material obtained from the following extraction and Abson recovery methods. Extract the asphalt by heating the adhesive just to the point where it will easily flow and then transfer 125 to 150 g into 400 ml of trichloroethylene with a temperature of 125°F to 150°F . Thoroughly stir this mixture to dissolve the asphalt. Decant the trichloroethylene-asphalt mixture decanted and the asphalt recovered using the Abson recovery method, ASTM D1856 as modified by the following. The extraction methods of ASTM D2172 do not apply and there will be no filtration of the solvent asphalt mixture. The extraction solution of trichloroethylene and asphalt shall be centrifuged for at least 30 minutes at 770 times gravity in a batch centrifuge. Decant this solution in the distillation flask, taking care not to include any filler sediment. Apply heat and bubble carbon dioxide solution slowly to bring the solution temperature to 300°F . At this point the carbon dioxide flow is increased to 800 ml to 900 ml per minute. The solution temperature is maintained at 320°F to 335°F with this carbon dioxide flow for at least 20 minutes and until the trichloroethylene vapors have been completely removed from the distillation flask. Repeat the above extraction-recovery method as necessary to obtain the desired quantity of asphalt. Use the asphalt recovered to determine penetration, 275°F viscosity, and 275°F viscosity ratio.

(4) Viscosity Ratio

Determine the 275°F viscosity ratio by comparing the 275°F viscosity on the base asphalt before and after the thin-film oven test. Perform the thin-film oven test in accordance with ASTM D1754. Determine the specific gravity by pycnometer as in ASTM D70 for use in the thin-film oven test. Calculate the 275°F viscosity ratio by dividing the viscosity after the thin-film oven test by the original 275°F viscosity.

(5) Filler Material

Separate the filler material from the asphalt to determine Filler Content and Filler Fineness. Determine the portion by weight of the adhesive insoluble in 1,1,1 trichloroethane by weighing 10.00 ± 0.01 grams of solid adhesive into

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a centrifuge flask with approximately 100 ml volume such as that specified in ASTM D1796. Add 50 ml of 1,1,1-trichloroethane to the adhesive, which should be broken up in small pieces to speed up the dissolution solids. Place the sample flask in a balanced centrifuge and spin using a minimum relative centrifugal force of 150 in accordance with ASTM D1796 for 10 minutes. Remove the sample flask and decant the solid, taking care not to lose any solids. Repeat the application of solvent and centrifuging until the solvent becomes clear and the filler is visually free of asphalt. Dry the filler at $160^{\circ}\text{F} \pm 5^{\circ}\text{F}$ to remove solvent and weigh the resulting filler. Filtration of the decanted solvent may be performed to verify there is no loss of filler. Percent filler content is calculated as follows:

$$\text{Filter Content, \% by Weight} = \frac{\text{Filler Weight, grams} \times 100}{\text{Original Adhesive Weight, grams}}$$

Determine Filler Fineness according to ASTM C430 using number 325, 200 and 100 sieves. This method is to be modified by using a water soluble non-ionic wetting agent, such as Triton X-100, to aid the wetting action. Concentration of the surfactant solution shall be approximately 1% by weight. Thoroughly wet the one-gram dry sample in the surfactant solution and allowed to soak for 30 minutes. Transfer the filler completely into the sieve cup and apply water spray for 2 minutes. Surfactant solution may be added as needed and physical means used to disperse any clumped particles. Dry the sample and handle as described in ASTM C430.

(C) Prequalification

Bituminous adhesives are required to be pre-qualified by the Department's Transportation-Traffic Engineering Branch. Interested parties shall submit a sample to a qualified independent testing laboratory for testing in accordance with Subarticle 1081-3(A) at no cost to the Department. Submit a Type 2 materials certification in accordance with Article 106-3 with the results and the name of the testing laboratory along with a qualification sample(s) of the same lot to the Department for evaluation. For more information on the pre-qualification process, contact the Work Zone Traffic Control Unit.

(D) Packaging and Labeling

Pack the adhesive in self-releasing cardboard containers which will stack properly. Containers shall have a net weight of 50 lbs. to 60 lbs. and contain two to four subcompartments. Ensure the label shows the manufacturer, quantity and batch number. Print "Bituminous Adhesive for Pavement Markers" or similar wording on the label.

(E) Certification

A certification from the manufacturer showing the physical properties of the bituminous adhesive and conformance with the Specifications shall be required before use.

(F) Application

Apply the adhesive according to the manufacturer's requirements and the following requirements.

Apply the adhesive when the road surface, ambient air and pavement marker temperatures are in the range of 50°F to 160°F on dry pavement.

The composition of the adhesive shall be such that its properties will not deteriorate when heated to and applied at temperatures up to 425°F using either air or oil-jacketed melters.

Melt and heat the bituminous adhesive in either thermostatically controlled double boiler type units using heat transfer oil or thermostatically controlled electric heating pots. Do not use direct flame units.

Heat the adhesive to between 375°F and 425°F and applied directly to the pavement surface from the melter/applicator by either pumping or pouring. Maintain the application temperature between 375°F and 425°F as lower temperatures may result in decreased adhesion while higher temperatures may damage the adhesive.

Use sufficient adhesive to insure total contact with the entire bottom of the pavement marker. Apply pavement markers to the adhesive immediately (within 5 seconds) to assure bonding. Place the pavement marker in position by applying downward pressure until the marker is firmly seated with the required adhesive thickness and squeeze-out. Remove excessive adhesive squeeze-out from the pavement and immediately remove adhesive on the exposed surfaces of pavement markers. Soft rags with mineral spirits conforming to Federal Specifications TT-T-291 or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent may be used.

Do not waste or spill any excess adhesive on Department right of way. Remove and properly dispose of any adhesive spilled or dumped at such location. The Contractor, at no cost to the Department, shall correct any damage incurred to the Department, highway or appurtenances as a result of misplaced adhesive.

The adhesive may be reheated and reused. However, the pot life at application temperatures shall not exceed the manufacturer's recommendations.

Clean out of equipment and tanks may be performed using petroleum solvents such as diesel fuel or similar materials. All solvents shall be removed from the equipment tanks and lines before the next use of the melter.

1081-4 EPOXY RESIN ADHESIVE FOR BONDING TRAFFIC MARKERS

(A) General

This section covers epoxy resin adhesive for bonding traffic markers to pavement surfaces.

(B) Classification

The types of epoxies and their uses are as shown below:

Type I

Rapid Setting, High Viscosity, Epoxy Adhesive. This type of adhesive provides rapid adherence to traffic markers to the surface of pavement.

Type II

Standard Setting, High Viscosity, Epoxy Adhesive. This type of adhesive is recommended for adherence of traffic markers to pavement surfaces when rapid set is not required.

Type III

Rapid Setting, Low Viscosity, Water Resistant, Epoxy Adhesive. This type of rapid setting adhesive, due to its low viscosity, is appropriate only for use with embedded traffic markers.

Type IV

Standard Set Epoxy for Blade Deflecting-Type Plowable Markers.

(C) Requirements

Epoxies shall conform to the requirements set for in AASHTO M237.

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(D) Prequalification

Refer to Subarticle 1081-1(E)

(E) Acceptance

Refer to Subarticle 1081-1(F)

SECTION 1082 STRUCTURAL TIMBER AND LUMBER

1082-1 GENERAL

Use Southern Pine timber and lumber graded in accordance with the current grading rules of the Southern Pine Inspection Bureau unless otherwise specified or approved by the Engineer. Use stress rated grades equal to or higher than the grades specified. For temporary crossings, the use of stress rated lumber having stress ratings below those specified may be used if approved by the Engineer.

Have all timber and lumber, including any preservative treatment, inspected and/or tested at no cost to the Department by an NCDOT approved commercial inspection company before it is delivered to the project. Provide industry standard commercial inspection reports for each shipment of untreated timber or lumber before its use on the project. Provide industry standard commercial inspection reports and treatment test reports for each shipment of treated timber or lumber before its use on the project. Perform all timber and lumber treatment inspections in accordance with Standard M2 (Part A) of the AWP A Specifications. In addition, brand, hammer mark, ink stamp or tag each piece of timber or lumber with the approved commercial inspection company's unique mark to indicate it has been inspected.

1082-2 UNTREATED TIMBER AND LUMBER

Lumber that is 2 to 4 inches thick and 2 inches to 4 inches wide shall conform to Structural Light Framing, Grade No. 1 Dense MC19. Lumber that is 2 inches to 4 inches thick and 6 inches wide or wider shall conform to Structural Joists and Planks, Grade No. 1 Dense MC19. Lumber that is 5 inches and thicker along the least dimension shall conform to, #1 Dense or Dense Select Structural (DSS). Rough lumber will be acceptable except where surfacing is called for by the contract. Rough lumber may vary $\pm 1/4$ inch from the dimensions shown on the contract or bill of material.

1082-3 TREATED TIMBER AND LUMBER

(A) General

Grade marked lumber will not be required. Brand or ink stamp each piece of treated lumber in accordance with the AWP A Standard M6.

(B) Bridges, Fender Systems and Piles

Lumber for bridges that is 2 inches to 4 inches thick and 2 inches to 4 inches wide shall conform to Structural Light Framing, Grade No. 1 Dense. Lumber for bridges that is 2 inches to 4 inches thick and 6 inches wide and wider shall conform to Structural Joists and Planks, Grade No. 1 Dense. Lumber for bridges that is 5 inches and thicker along the least dimension shall conform to Structural Lumber, #1 Dense or Dense Select Structural (DSS). Lumber for fender systems shall conform to Structural Lumber, #1 Dense or Dense Select Structural (DSS).

Timber for piles shall meet ASTM D25 except that the timber shall be Southern Pine, and have at least a 2 inches sap ring or a 3 inches sap ring where called for by the contract or where the preservative is creosote and the retention is greater than 18 lbs/cf.

Rough lumber will be acceptable except where surfacing is called for by the contract or bills of material. Rough lumber may vary $\pm 1/4$ inch from the dimensions shown in the