SPECIFICATION P–306. ECONOCRETE SUBBASE COURSE

DESCRIPTION

306–1.1 This Work consists of constructing a subbase course composed of aggregate and cement uniformly blended together and mixed with water, spread, shaped, and compacted in accordance with these Specifications and in conformity to the lines, grades, dimensions, and typical cross sections shown on the Plans.

MATERIALS

306–2.1 AGGREGATE. Provide aggregates in accordance with ASTM C 33. Aggregate shall be stone or gravel, crushed or uncrushed. Fine aggregate may be that naturally contained in the aggregate material or may be sand. Aggregate shall consist of hard, durable particles, free from excess flat, elongated, soft pieces, dirt, or other objectionable matter. Aggregate may also be a slag suitable for concrete.

A flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

NOTE TO SPECIFIER:
The Engineer may specify crushed portland cement concrete pavement if the existing pavement or material on hand is to be recycled.

The aggregate shall conform to the gradation shown in Table 1 when tested in accordance with ASTM C 136. Provide gradation No. 1 unless otherwise specified in the Special Provisions.

TABLE 1. AGGREGATE – ECONOCRETE SUBBASE COURSE
Percentage by Weight Passing Sieves

Sieve Size/Gradation (square opening)	*Gradation No. 1 1"(25.0 mm) Maximum*	*Gradation No. 1A 1–1/2"(37.5 mm) Maximum*	*Gradation No. 2 2" (50.0 mm) Maximum*
2 in (50.0 mm)			100
1–1/2 in (37.5 mm)		100	
1 in (25.0 mm)	100	70–95	55–85
3/4 in (19.0 mm)	70–100	55–85	50–80
No. 4 (4.75 mm)	35–65	30–60	30–60
No. 40 (0.450 mm)	14–30	10–30	10–30
No. 200 (0.075 mm)	0–15	0–15	0–15

NOTE TO SPECIFIER:
Where locally available aggregate cannot economically be blended to meet the grading requirements, or if recycled pavement is used, the gradations may be modified by the design Engineer to fit the characteristics of the available aggregates provided strength requirements are met.

If gradation 1A or 2 is desired, add the requirement in a Special Provision.

306–2.2 CEMENT. Cement shall conform to the requirements of ASTM C 150, Type 1.

306–2.3 WATER. Water used in mixing or curing shall be as clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product as possible. Water shall meet the requirements of AASHTO T 26. Water known to be of potable quality may be used without testing.

306–2.4 COVER MATERIAL FOR CURING. Curing materials shall conform to one of the following specifications:

a. Liquid membrane–forming compounds for curing econocrete shall conform to the requirements of ASTM C 309, Type 2, Class A or B.

b. Asphalt emulsion for curing econocrete shall conform to the requirements of ASTM D 977, Type SS–1h.

306–2.5 ADMIXTURES. The Engineer will approve materials added to the econocrete mix. Submit certificates indicating that the material to be furnished meets all the requirements listed below. In addition, the Engineer may require the Contractor to submit complete test data showing that the material to be furnished meets all the requirements of the cited Specification.

a. Pozzolanic Admixtures. Pozzolanic admixtures shall be fly ash or raw or calcined natural pozzolans meeting the requirements of ASTM C 618.

b. Air–Entraining Admixtures. Air entraining admixtures shall meet the requirements of ASTM C 260.

c. Water Reducing Admixtures. Water reducing admixtures shall meet the requirements of ASTM C 494, Type A, water–reducing or Type D, water–reducing and retarding. Add water–reducing admixtures at the mixer separately from air–entraining admixtures in accordance with the manufacturer's printed instructions. The air entrainment agent and the water–reducing admixture shall be compatible.

NOTE TO SPECIFIER:
Since the cement content is low in econocrete (which could cause poor workability for normal aggregates), the workability may be increased by extra fines in the aggregate; higher than normal amounts of entrained air; addition of pozzolanic admixtures or workability agents; or a combination of these.

CONSTRUCTION METHODS

306–3.1 PROPORTIONING. Prior to the start of paving operations and after approval of all material to be used, submit a mix design and test data showing the proportions of materials used and the actual compressive strength obtained from the econocrete. Compressive strength shall be not less than 500 psi (3447 kPa) at 7 days and 750 psi (5171 kPa) at 28 days, or more than 1,200 psi (8274 kPa) at 28 days, using test specimens prepared in accordance with ASTM C 192 and tested in accordance with ASTM C 39. The minimum cementitious material (cement plus fly ash) shall be 200 pounds per cubic yard (119 kg per cubic meter). When fly ash is used as a partial replacement for cement, the minimum cement content may be met by considering Portland cement plus fly ash as the total cementitious material. The replacement rate shall be determined from laboratory trial mixes, but shall not exceed 20 percent by weight of the total cementitious material.

NOTE TO SPECIFIER:
The Engineer may wish to specify aAn upper limit of 1200 psi (8268 kPa) is specified since a comprehensive strength greater than 1200 psi (8268 kPa) may induce cracking in the overlying pavement.

When adding air–entraining admixture ensure uniform distribution of the agent throughout the batch. The percentage of air entrainment shall not be less than 6 percent or more than 10 percent. Test air content in accordance with ASTM C 231 for gravel and stone coarse aggregate and ASTM C 173 for slag and other highly porous coarse aggregate. Provide a mix with a slump of 2 inches (50 mm) at the time of placing the econocrete. Testing shall be in accordance with ASTM C 143. The freeze–thaw weight loss shall not exceed 14 percent when tested in accordance with ASTM D 560.

306–3.2 EQUIPMENT. The Engineer will approve equipment and tools necessary for handling materials and performing all parts of the Work as to design, capacity, and mechanical condition. Have the equipment at the job site before the start of construction operations for examination and approval.

a. Batch Plant and Equipment. The batch plant and equipment shall conform to the requirements of ASTM C 94.

b. Mixers.

(1) **General**. Econocrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

(2) **Central Plant Mixer**. Central plant mixers shall conform to the requirements of ASTM C 94. Examine the mixers for changes in condition due to accumulation of hard concrete or mortar or wear of blades. Replace the pickup and throwover blades when they have worn down 3/4 inch (19 mm) or more. Have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

(3) **Truck mixers and truck agitators**. Truck mixers used for mixing and hauling econocrete and truck agitators used for hauling central–mixed econocrete shall conform to the requirements of ASTM C 94.

(4) **Nonagitator trucks**. Nonagitating hauling equipment shall conform to the requirements of ASTM C 94.

c. Finishing Equipment.

(1) **Finishing Machine**. The finishing machine shall be equipped with one or more oscillating–type transverse screeds.

(2) **Vibrators**. For side–form construction, vibrators may be either the surface pan type for pavements less than 8 inches (200 mm) thick or the internal type with either immersed tube or multiple spuds for the full width of the slab. They may be attached to the spreader or the finishing machine, or they may be mounted on a separate carriage. Do not allow the vibrators to come in contact with

the joint, subgrade, or side forms. The frequency of the surface vibrators shall not be less than 3,500 vibrations per minute, and the frequency of the internal type shall not be less than 7,000 vibrations per minute for spud vibrators. When spud–type internal vibrators are used adjacent to the side forms, they shall have a frequency of not less than 3,500 vibrations per minute.

For slip–form construction, the paver shall vibrate the econocrete for the full width and depth of the strip of pavement being placed. Accomplish vibration by internal vibrators with a frequency range variable between 7,000 and 12,000 vibrations per minute. The amplitude of vibration shall be between 0.025 and 0.06 inches (0.6 mm and 1.5 mm).

Provide, as necessary, the number, spacing, frequency, and eccentric weights to achieve an acceptable density and finishing quality. Adequate power to operate all vibrators at the weight and frequency required for a satisfactory finish shall be available on the paver. The internal vibrators may be supplemented by vibrating screeds operating on the surface of the econocrete. The frequency of surface vibrators shall not be less than 3,500 vibrations per minute. Furnish a tachometer or other suitable device for measuring the frequency of the vibrators. The vibrators and tamping elements shall be automatically controlled so that they can be stopped as forward motion ceases. Override switches shall be of the spring–loaded, momentary–contact type.

d. Concrete Saw. When sawing joints is specified or is necessary in accordance with 306–3.10, provide sawing equipment with adequate power to complete the sawing to the required dimensions and at the required rate. Provide at least one standby saw in good working order. Maintain an ample supply of saw blades at the site of the Work at all times during sawing operations. Provide adequate artificial lighting facilities for night sawing. Have all of this equipment on the job both before and at all times during econocrete placement.

e. Forms. Straight side forms shall be made of steel having a thickness of not less than 7/32 inch (6 mm) and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall have a depth equal to the prescribed edge thickness of the econocrete without horizontal joint and a base width equal to the depth of the forms. Use flexible or curved forms of proper radius for curves of 100–feet (30 m) radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer. Provide forms with devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than two–thirds the height of the form. Remove from the Work forms with battered top surfaces and bent, twisted, or broken forms. Do not use repaired forms, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting.

f. Slip–form Pavers. Ensure the paver is fully energized, self–propelled, and designed for the specific purpose of placing, consolidating, and finishing the econocrete pavement, true to grade, tolerances, and cross section. Ensure it is of sufficient weight and power to construct the maximum specified paving lane width as shown in the Plans, at adequate forward speed, without transverse, longitudinal, or vertical instability or without displacement. Equip the paver with electronic or hydraulic horizontal and vertical control devices.

306–3.3 FORM SETTING. Set forms sufficiently in advance of the econocrete placement to ensure continuous paving operation. After the forms have been set to correct grade, thoroughly tamp the grade, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Stake into place forms with not less than 3 pins for each 10–foot (3 m) section. Place a pin at each side of every joint.

Tightly lock form sections and ensure they are free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch (6 mm) at any joint. Set forms so that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Clean and oil forms prior to the placing of econocrete.

Check the alignment and grade elevations of the forms and make corrections immediately before placing the econocrete. When forms have been disturbed or grades have become unstable, reset and recheck the form.

306–3.4 CONDITIONING OF UNDERLYING COURSE, SLIP–FORM CONSTRUCTION. Widen the compacted subgrade on which the pavement will be placed approximately 3 feet (0.90 m) to extend beyond the paving machine track to support the paver without any noticeable displacement. After the subgrade has been placed and compacted to the required density, trim the areas that will support the paving machine and the area to be paved to the proper elevation and profile by means of a properly designed machine. Control automatically the grade of the subgrade on which the econocrete pavement is to be placed by steel guide wires erected and maintained by the Contractor. If the density of the subgrade is disturbed by the trimming operations, re-compact before the econocrete is placed. Delay the grading operations as long as possible to immediately precede paving insofar as practicable, particularly if the subgrade is subjected to haul traffic. If traffic is allowed to use the prepared grade, check and correct the grade immediately before the placement of econocrete. Moisten the prepared grade well , without saturating, immediately ahead of econocrete placement to prevent rapid loss of moisture from the econocrete. In cold weather, protect the underlying course so that it will be entirely free of frost when econocrete is placed.

306–3.5 CONDITIONING OF UNDERLYING COURSE, SIDE–FORM CONSTRUCTION. Moisten the prepared grade well , without saturating, immediately ahead of econocrete placement to prevent rapid loss of moisture from the econocrete. Fill ruts or depressions in the subgrade, caused by hauling or usage of other equipment, as they develop with suitable material and thoroughly compact by rolling. A multi–pin template weighting not less than 1,000 pounds (450 kg) per 20 feet (6 m) or other approved templates shall be provided and operated on the forms immediately in advance of the placing of the econocrete. Propel the template by hand and do not attach it to a tractor or other power unit. Provide adjustable templates so that they may be set and maintained at the correct contour of the underlying course. Adjust and operate the templates to provide an accurate retest of the grade before

placing the econocrete. Remove all excess material. Low areas may be filled and compacted to a condition similar to that of the surrounding grade, or filled with econocrete integral with the pavement. In cold weather, protect the underlying course so that it will be entirely free from frost when the econocrete is placed. The use of chemicals to eliminate frost in the underlying material will not be permitted. Maintain the template in accurate adjustment and check it daily. The Work described under the foregoing paragraphs does not constitute a regular subgrading operation, but rather a final accurate check of the underlying course.

306–3.6 HANDLING, MEASURING, AND BATCHING MATERIAL. The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the Work. Build stockpiles in layers of not more than 3 feet (0.90 m) in thickness. Each layer shall be completely in place before beginning the next layer and shall not be allowed to "cone" down over the next lower layer. Do not stockpile aggregates from different sources and of different grading together. The Engineer will not accept improperly placed stockpiles.

Handle aggregates from stockpiles or other sources to the batching to secure the specified grading of the material. Do not use aggregates that have become segregated or mixed with earth or foreign material. Stockpile or bin all aggregates for draining that are produced or handled by hydraulic methods, and washed aggregates, for at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. Weigh the fine aggregate and coarse aggregate in separate hoppers in the respective amounts set in the job mix except where a unit aggregate such as crusher run or pit run are used, in which case a single stockpile will be satisfactory Measure cement by weight. Use separate scales and hopper, with a device to positively indicate the complete discharge of the batch of cement into the batch box or container, for weighing the cement.

When required by the Contract or when permitted, equip batching plants to proportion aggregates and bulk cement, by weight, automatically using interlocked proportioning devices of an approved type. Use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer (for example, chute, boot, or other approved device) to prevent loss of cement. Arrange the device to provide positive assurance of the actual presence in each batch of the entire cement content specified.

When cement is placed in contact with the aggregates, batches may be rejected unless mixed within 1–1/2 hours of the contact. Conduct batching so that the results in the weights of each material required will be within a tolerance of 1 percent for cement and 2 percent for aggregates.

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within plus or minus 1 percent of required amounts. Unless the water is to be weighed, the water–measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled.

When required, the Engineer will approve methods and equipment for adding air–entraining agents or other admixtures to the batch. Measure all admixtures into the mixer with an accuracy of plus or minus 3 percent.

306–3.7 MIXING ECONOCRETE. The econocrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Measure mixing time from the time all materials, except water, are emptied into the drum. Mix and deliver ready–mixed econocrete in accordance with the requirements of ASTM C 94, except the minimum required revolutions of the mixing speed for transit mixed econocrete may be reduced to not less than that recommended by the mixer manufacturer. Indicate the number of revolutions recommended by the mixer manufacturer on the manufacturer's serial plate attached to the mixer. Furnish test data acceptable to the Engineer verifying that the make and model of the mixer will produce uniform econocrete conforming to the provisions of ASTM C 94 at the reduced number of revolutions shown on the serial plate.

When mixed at the work site or in a central mix plant, the mixing time shall not be less than 50 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. Remove the contents of an individual mixer drum before a succeeding batch is emptied therein.

Operate the mixer at the drum speed as shown on the manufacturer's nameplate on the approved mixer. Discard, at the Contractor's expense, econocrete that is mixed less than the specified time. The volume of econocrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet (cubic meters), as shown on the manufacturer's standard rating plate on the mixer. An overload up to 10 percent above the mixer's nominal capacity may be permitted provided test data for segregation and uniform consistency are satisfactory, and provided no spillage of econocrete takes place. Charge the batch into the drum so that a portion of the mixing water enters in advance of the cement and aggregates. Provide a uniform flow of water. Have all water in the drum by the end of the first 15 seconds of the mixing period. Keep the throat of the drum free of accumulations that may restrict the free flow of materials into the drum.

Transport mixed econocrete from the central mixing plant in truck mixers, truck agitators, or nonagitating trucks. Do not exceed 45 minutes for the time elapsing from the time water is added to the mix until the econocrete is deposited in place at the Work site when the econocrete is hauled in nonagitating trucks, and do not exceed 90 minutes when the econocrete is hauled in truck mixers or truck agitators. Retempering econocrete by adding water or by other means will not be permitted, except when econocrete is delivered in transit mixers. With transit mixers, additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, if permitted by the Engineer. All these operations must be performed within 45 minutes after the initial mixing operations, and the water–cement ratio must not be exceeded. Admixtures for increasing the workability or for accelerating the set will be permitted only when approved by the Engineer. At the option of the Contractor or when specified by the Engineer, a water–reducing admixture may be used.

306–3.8 LIMITATIONS OF MIXING. Do not mix, place, or finish econocrete when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

Unless authorized in writing by the Engineer, discontinue mixing and econocreting operations when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C). Do not resume mixing and econocrete operations until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

When econocreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. Heat the mass uniformly and arrange it to preclude the possible occurrence of overheated areas that might be detrimental to the materials. Unless otherwise authorized, the temperature of the mixed econocrete shall not be less than 50°F (10°C) at the time of placement in the forms.

If the air temperature is 35°F (2°C) or less at the time of placing econocrete, the Engineer may require the water and/or the aggregates to be heated to not less than 70°F (20°C) nor more than 150°F (66°C). Do not place econocrete on frozen subgrade or use frozen aggregates in the econocrete.

During the periods of warm weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions should be taken:

a. Sprinkle the forms and/or the underlying material with water immediately before placing the econocrete.

b. Place the econocrete at the coolest temperature practicable, and in no case should the temperature of the econocrete when placed exceed 100°F (38°C).

c. Cool the aggregates and/or mixing water as necessary to maintain the econocrete temperature at or not more than the specified maximum.

306–3.9 PLACING ECONOCRETE.

a. Side–Form Method. Deposit the econocrete on the moistened grade to require as little rehandling as possible. Truck mixers, truck agitators, or nonagitating hauling equipment equipped with means for discharge of econocrete without segregation of the materials, shall unload the econocrete on the grade to prevent segregation of the materials. Place the econocrete continuously between transverse joints without the use of intermediate bulkheads. Do necessary hand spreading with shovels (not rakes). Do not allow workers to walk in the freshly mixed econocrete with boots or shoes coated with earth or foreign substances.

b. Slip–Form Method. Place the econocrete with an approved crawler–mounted, slip–form paver designed to spread, consolidate, and shape the freshly placed econocrete in one complete pass of the machine so that a minimum of hand finishing will be necessary to provide a pavement in conformance with requirements of the Plans and Specifications. Provide adjustable side forms and finishing screeds to the extent required to produce the specified pavement edge and surface tolerance. The side forms shall be of dimensions, shape, and strength to support the econocrete laterally for a sufficient length of time so that no appreciable edge slumping will occur. Accomplish final finishing while the econocrete is still in the plastic state.

306–3.10 JOINTS. Construct transverse joints in econocrete subbases if compressive strengths exceed the following limitations:

28 day compressive strength of mix design, per project ..... 1,200 psi
Average 28 day compressive strengths as determined in 306–4.1, per lot ..... 1,200 psi
Average 7 day compressive strength as determined in 306–4.1, per lot ..... 800 psi

If one of the above events occurs, construct transverse joints every 50 feet (15 m). Saw joints in the hardened econocrete or formed in the plastic mixture to a depth of at least one-sixth the thickness of the econocrete base. Offset all joints in the econocrete base at least 6 inches (150 mm) from joints in the surface course.

NOTE TO SPECIFIER:
Joints are not considered necessary to econocrete subbases due to the normally lower strengths and moduli of elasticity of these subbases relative to these parameters in the overlying Portland cement concrete pavement. When a relatively high strength econocrete subbase is placed (compressive strength greater than 1200 psi), joints should be constructed, unless a good bond breaker, such as a wax-based curing compound, is used between the econocrete and the overlying pavement.

306–3.11 FINAL STRIKE–OFF, CONSOLIDATION, AND FINISHING.

a. Sequence. The sequence of operations is strike–off, consolidation, and finishing.

b. Strike–off, Consolidation, and Finishing. Place the econocrete with a slip–form paver capable of striking–off, consolidating, and finishing in one pass of the equipment. Using form–paving methods is optional.

c. Surface Testing and Corrections. After the econocrete base has been struck off and consolidated and while the econocrete is still plastic, test it for trueness with a 16–foot (4.8 m) straightedge. Show no variations in the surface of more than 3/8 inch (9 mm) from a 16–foot (4.8 m)

straightedge laid in any location parallel with or at right angles to the longitudinal axis of the centerline. Remove surplus material and refinish the surface by hand. Immediately fill depressions with freshly mixed econocrete, struck off, consolidated, and refinished.

306–3.12 CURING. Immediately after the finishing operations have been complete and marring of the econocrete will not occur, cure the entire surface of the newly placed econocrete in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of econocreting operations. Do not leave the econocrete exposed for more than 1/2 hour during the curing period. The following are alternate approved methods for curing econocrete pavements.

a. Impervious Membrane Method. Spray the entire surface of the pavement uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the econocrete has taken place. Do not apply the curing compound during rainfall. Apply curing compound by mechanical sprayers under pressure at the rate of 1 gallon (4 liters) to not more than 200 square feet (18 square meters). Use fully atomizing spraying equipment equipped with a tank agitator. At the time of use, thoroughly mix the compound with pigment uniformly dispersed throughout the vehicle. During application, stir the compound continuously by effective mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. Do not apply curing compound to the inside faces of joints to be sealed, but use approved means to ensure proper curing for 72 hours. Use a curing compound where the film will harden within 30 minutes after application. Should the film become damaged from any cause within the required curing period, repair the damaged portions immediately with additional compound. Upon removal of side forms, protect the sides of the exposed slabs immediately to provide a curing treatment equal to that provided for the surface.

b. Asphalt Emulsion. Uniformly spray the entire surface of the pavement with asphalt emulsion before the set of the econocrete has taken place. Apply the asphalt emulsion by distributing equipment at the rate of approximately 0.2 gallons (0.95 liter) per square yard (square meter). Should the film become damaged from any cause within the required curing period, repair the damaged portions immediately with additional asphalt emulsion.

c. Curing in Cold Weather. When the average daily temperature is below 40°F (4°C), curing consists of covering the newly laid pavement with not less than 12 inches (300 mm) of loose, dry hay or straw, or equivalent protective curing authorized by the Engineer, which shall be retained in place for 10 days. Secure the hay or straw to avoid being blown away.

When econocrete is being placed and the air temperature may be expected to drop below 35°F (2°C), provide a sufficient supply of straw, hay, grass, or other suitable blanketing material such as burlap or polyethylene along the Work. Whenever the temperature is expected to reach the freezing point during the day or night, spread the material so provided over the pavement to a sufficient depth to prevent freezing of the econocrete.

Maintain this protection for at least 10 days. The Contractor shall be responsible for the quality and strength of the econocrete placed during cold weather, and econocrete injured by frost action shall be removed and replaced at the Contractor's expense.

306–3.13 PROTECTION OF ECONOCRETE. Protect the pavement against traffic caused by the Contractor's employees and agents. This includes watchmen to direct traffic and erection and maintenance of warning signs, lights, pavement bridges, or crossovers, etc. The Plans or Special Provisions will indicate the location and type of device or facility required to protect the Work and provide adequately for traffic. Repair damage to the subbase course occurring prior to final acceptance or replace the pavement at the Contractor's expense. Have available at all times materials for the protection of the edges and surfaces of the unhardened econocrete to protect against the effects of rain. The protective materials consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic econocrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic econocrete surface. When rain appears imminent, stop all paving operations and have all available personnel begin covering the surface of the unhardened econocrete with the protective covering.

Do not permit traffic on the econocrete until a minimum compressive strength of 500 psi has been developed as determined from test specimens.

MATERIAL ACCEPTANCE

306–4.1 ACCEPTANCE SAMPLING AND TESTING. The Engineer will perform all acceptance sampling and testing, except for coring for thickness determination, necessary to determine conformance with the requirements specified in this Section. Econocrete will be accepted for strength and thickness on a lot basis.

Testing organizations performing these tests will meet the requirements of ASTM C 1077. Bear the cost of providing curing facilities for the strength specimens, per paragraph 306–4.1a(4), and coring and filling operations, per paragraph 306–4.1b(2).

a. Compressive Strength.

(1) Lot Size. A strength lot will consist of:

One day's production not to exceed approximately 2,000 cubic yards

A half day's production where a day's production is expected to consist of between approximately 2,000 cubic yards and approximately 4,000 cubic yards

Similar subdivisions for a day's production of over 4,000 cubic yards

If a single day's production is expected to be less than approximately 1,000 cubic yards but more than approximately 500 cubic yards, it will become two (2) sublots and added to the next lot, i.e., n=6.

If a single day's production is expected to be less than approximately 500 cubic yards, it will become one sublot for the next lot, i.e., n=5.

(2) Sampling. Each lot will be divided into four equal sublots. One specimen will be made by the Engineer for each sublot from the plastic econocrete delivered to the job site to determine strength. The Engineer will determine sampling locations in accordance with random sampling procedures contained in ASTM D 3665. The econocrete will be sampled in accordance with ASTM C 172.

The Engineer will convert the above cubic yard lot sizes into equivalent square yard areas in the increments shown above.

Test ages of the specimens will be 7 days and 28 days. One set of specimens (one 7–day cylinder and three 28–day cylinders) will be made for every sublot placed. Each set of specimens will be molded from the same batch of econocrete and will consist of one cylinder to provide a 7–day compressive strength test and two cylinders to provide a 28–day compressive test (the extra cylinder will be a back–up in the event of an obvious defective cylinder).

When it appears that the 7-day test specimens will fail to conform to the requirements for strength, the Engineer will have the right to order changes in the econocrete sufficient to modify the strength to meet these requirements. When a satisfactory relationship between 7–day and 28–day strengths has been established and approved, the 7–day test results may be used as an indication of the 28–day strengths However, the 7–day test results will not replace the results of the 28–day tests if the 28–day results fall below the requirements.

(3) Testing. Specimens will be made in accordance with ASTM C 31 and the compressive strength of each specimen will be determined in accordance with ASTM C 39.

(4) Curing. Provide adequate facilities for the initial curing of test specimens. During the 48 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, under wet burlap in favorable weather, in heavyweight closed plastic bags, or by other suitable methods provided the temperature and moisture loss requirements are met.

(5) Partial Lots. When operational conditions cause a strength lot to be terminated before the specified four tests have been made for the lot, the following procedure will be used to adjust the lot size and the number of tests for the lot:

Three sublets will constitute a lot. One or two sublots, will be incorporated into the next lot (or the previous lot if at the end of production) and the total number of sublots shall be used in the acceptance criteria calculation, i.e., n=5 or n=6.

b. Pavement Thickness.

(1) Lot Size. A thickness lot will consist of 4,000 square yards (3,350 square meters).

(2) Sampling. Take one core for each thickness lot. The Engineer will determine sampling locations in accordance with random sampling procedures contained in ASTM D 3665.

When measurement taken in accordance Section 306–4.1(b)3 shows the core is deficient more than 0.5 inch (12 mm) from the plan thickness, take two additional cores at random and use in determining the average thickness for that lot.

Cut cores neatly with a core drill. Furnish all tools, labor, and materials for cutting samples and filling the cored hole. Fill core holes with a non–shrink grout approved by the Engineer within one day after sampling.

(3) Testing. The Engineer will determine the thickness of the cores by the average caliper measurement in accordance with ASTM C 174.

306–4.2 ACCEPTANCE CRITERIA.

a. General. Acceptance will be based on the following characteristics of the completed pavement:

(1) Compressive strength
(2) Thickness
(3) Smoothness

Compressive strength will be evaluated for acceptance in accordance with paragraph 306–4.2b. The Engineer will evaluate thickness for acceptance in accordance with paragraph 306–4.2c. The Engineer will evaluate smoothness in accordance with paragraph 306–4.2d.

The Engineer may at any time, not withstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of econocrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

b. Compressive Strength. Acceptance of each lot of in–place econocrete for compressive strength will be based on the percentage of material within specification limits (PWL). The PWL plan considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results. If a material with high variability is produced, then a higher average strength must be maintained in order to achieve a PWL of 80 percent or more.

The percentage of material within limits will be determined in accordance with procedures specified in Section 110, Method of Estimating Percentage of Material within Specification Limits (PWL) of the General Requirement and Covenants.

The lower specification limit (L) for compressive strength will be the 28-day design strength given in paragraph 306–3.1, Proportioning. If the PWL of the lot equals or exceeds 80 percent for compressive strength, the pay factor for the lot will be 1.0, as determined in accordance with paragraph 306–7.1a. If the PWL is less than 80 percent, the pay factor for the lot will be less than 1.0, as determined in accordance with paragraph 306–7.1a.

c. Pavement Thickness. Acceptance of each lot of in–place econocrete will be based on the following:

If the measurement of the core from a lot is not deficient more than 0.5 inch (12 mm) from the Plan thickness, the pay factor will be 1.0. When three cores were taken in accordance with 306–4.1(b)2, and the average of the three cores is not deficient more than 0.5 inch (12 mm) from Plan thickness, the pay factor will be 1.0. If the average of three cores is deficient more than 0.5 inch (12 mm) from the Plan thickness, the entire lot will be removed and replaced at the Contractor's expense or be permitted to remain in–place at an adjusted payment in accordance with 306–7.1b.

d. Pavement Smoothness. Surface testing and corrections to the plastic econocrete will be in accordance with 306–3.11(c). As soon as the econocrete has hardened sufficiently, the Engineer will test the econocrete surface with a 16–foot (5 m) straightedge or other specified device. Surface smoothness deviations shall not exceed 3/8 inch (10 mm) from a 16–foot (5 m) straightedge placed in any direction.

Areas in a slab showing high spots of more than 3/8 inch (10 mm) but not exceeding 3/4 inch (19 mm) in 16 feet (5 m) will be marked. Grind down high spots with an approved grinding machine to an elevation that will fall within the tolerance of 3/8 inch (10 mm) or less. Where the departure from correct cross section exceeds 3/4 inch (19 mm), remove the pavement and replace it at the expense of the Contractor when so directed by the Engineer.

CONTRACTOR QUALITY CONTROL

306–5.1 QUALITY CONTROL PROGRAM. Develop a Quality Control Program in accordance with Section 100, Method of Estimating Percentage of Material within Specification Limits, of the General Provisions. The program shall address all elements that effect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Gradation

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Placing and Consolidation

h. Compressive Strength

k. Finishing and Curing

l. Surface Smoothness

m. Thickness

NOTE TO SPECIFIER:
When the design requires paving an area less than 600 square yards (500 square meters), the Engineer may request modification to this requirement by Special Provisions.

306–5.2 QUALITY CONTROL TESTING. Perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. Include in the testing program, but not necessarily limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

Develop a Quality Control Testing Plan as part of the Quality Control Program.

a. Aggregate.

(1) Gradation. Make a sieve analysis at least twice daily in accordance with ASTM C 136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture Content. If an electric moisture meter is used, make at least two direct measurements of moisture content per week to check the calibration. If direct measurements are made instead of using an electric meter, make two tests per day. Make tests in accordance with ASTM C 70 or ASTM C 566.

b. Slump. Perform four slump tests for each lot of material produced in accordance with the lot size defined in Section 306–4.1. Make one test for each sublot. Perform slump tests in accordance with ASTM C 143 from material randomly sampled from material discharged from trucks at the paving site. Take material samples in accordance with ASTM C 172.

c. Air Content. Perform four air content tests, for each lot of material produced in accordance with the lot size defined in Section 306–4.1. Make one test for each sublot. Perform air content tests in accordance with ASTM C 231 for gravel and stone coarse aggregate and ASTM C 173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the plant site. Take material samples in accordance with ASTM C 172.

306–5.3 CONTROL CHARTS. Maintain linear control charts for aggregate gradation, slump, and air content.

Post control charts in a location satisfactory to the Engineer and keep it up to date at all times. As a minimum, the control charts shall identify the project number, the Contract Item number, the test number, each test parameter, the Action and Suspension Limits, or Specification limits, applicable to each test parameter, and the test results. Use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the projected data during production indicates a potential problem and satisfactory corrective action is not being taken, the Engineer may halt production or acceptance of the material.

a. Aggregate Gradation. Record the running average of the last five gradation tests for each control sieve on linear control charts. Superimpose specification limits contained in Tables 1 on the Control Chart for job control.

b. Slump and Air Content. Maintain linear control charts both for individual measurements and range (i.e. difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

TABLE 1. CONTROL CHART LIMITS
Based on Sample Size n=4

Control Parameter	*Individual Measurements*		*(n=4)*
	Action Limit	*Suspension Limit*	*Range Suspension Limit*
Slump	±1 inch (25 mm)	±1.5 inch (38 mm)	±2.0 inch (51 mm)
Air	±1.2%	±1.8%	±2.8%

The individual measurement control charts shall use the mix design target values as indicators of central tendency.

306–5.4 CORRECTIVE ACTION. Indicate on the Quality Control Plan that appropriate action shall be taken when the process is believed to be out of control. Detail in the Quality Control Plan what action will be taken to bring the process into control and detail sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

a. Aggregate Gradation. When two consecutive averages of five tests are outside of the Tables 1 specification limits, take immediate steps, including a halt to production, to correct the grading.

b. Aggregate Moisture Content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5 percent, adjust the scale settings for the aggregate batcher(s) and water batcher.

c. Slump. Halt production and make appropriate adjustments whenever:

(1) One point falls outside the Suspension Limit line for individual measurements or range; or

(2) Two points in a row fall outside the Action Limit line for individual measurements.

d. Air Content. Halt production and adjust the amount of air–entraining admixture whenever:

(1) One point falls outside the Suspension Limit line for individual measurements or range; or

(2) Two points in a row fall outside the Action Limit line for individual measurements.

Whenever a point falls outside the Action Limits line, calibrate the air–entraining admixture dispenser to ensure that it is operating correctly and with good reproducibility.

METHOD OF MEASUREMENT

306–6.1 Econocrete Subbase Course will be measured for payment by the number of square yards in–place, completed and accepted.

The Econocrete Subbase Contractor Quality Control Program will be measured for payment by the square yards of econocrete subbase course placed, completed and accepted.

BASIS OF PAYMENT

306–7.1 GENERAL. Payment for an accepted lot of Econocrete Subbase Course will be made at the Contract unit price per square yard adjusted in accordance with paragraphs 306–7.1a,b. Payment will be full compensation for all labor, materials, tools equipment, and incidentals required to complete the Work as specified herein and on the drawings.

The Quality Control Program, Econocrete Subbase Course will be measured for payment by the square yard of econocrete placed, completed and accepted.

a. Basis of Adjusted Payment for Compressive Strength (PF_S). A pay factor for compressive strength will be determined in accordance with the following schedule when the percent within specification limits (PWL) equals or exceeds 60 percent.

Percent within limits (PWL)	Pay Factor for Compressive Strength (PF_S)
80–100	$0.76 + 0.003\ PWL$
60–79	$0.00017\ PWL^2 - 0.0105\ PWL + 0.75$

When the PWL is below 60 percent, the lot will be removed and replaced. However, the Engineer may decide to accept the deficient lot. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, it will be paid for at 50 percent of the Contract unit price.

b. Basis of Adjusted Payment for Thickness (PF_T). A pay factor for thickness will be determined in accordance with the following:

If the pay factor in accordance with 306–4.2c is 1.0, full payment will be made.

If the pay factor is less than 1.0, and the Engineer and Contractor agree in writing that the lot shall not be removed, the deficient lot may be paid for at 75 percent of the Contract unit price.

306–7.2 PAYMENT FOR QUALITY CONTROL PROGRAM. Payment for the Quality Control Program, Econocrete Subbase Course will be made at the Contract unit price per square yard for Quality Control Program, Econocrete Subbase Course.

Payment will be made under:

Pay Item P30601	Econocrete Subbase Course, per square yard
Pay Item P30602	Econocrete Subbase Contractor Quality Management Program, per square yard

Measurement and Payment will only be made for Items included in the Schedule of Prices. The cost of all Work required by the Contract Documents will be included in the Pay Items contained in the Schedule of Prices.

TESTING REQUIREMENTS

ASTM C 31	Making and Curing Concrete Test Specimens in the Field
ASTM C 39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C 70	Surface Moisture in Fine Aggregate
ASTM C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	Test for Slump of Portland Cement Concrete
ASTM C 172	Sampling Freshly Mixed Concrete
ASTM C 173	Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 174	Measuring Length of Drilled Concrete Cores
ASTM C 192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	Test for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 560	Freezing and Thawing Test of Compacted Soil Cement
ASTM C 566	Total Moisture Contents of Aggregates by Drying
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 75	Standard Practice for Sampling Aggregates
ASTM D 3665	Random Sampling of Construction Materials
AASHTO T 26	Quality of Water to be Used in Concrete

MATERIAL REQUIREMENTS

ASTM C 33	Specification for Concrete Aggregates
ASTM C 94	Specification for Ready–Mixed Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 260	Specification for Air–Entraining Admixtures for Concrete
ASTM C 309	Specification for Liquid Membrane–Forming Compounds
ASTM C 494	Specification for Chemical Admixtures for Concrete
ASTM C 618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 977	Specifications for Emulsified Asphalt
ASTM C 989	Specification for Ground Granulated Blast–Furnace Slag for Use in Concrete and Mortars