CONSTRUCTION OF PAVEMENT SUBSURFACE DRAINAGE SYSTEMS
(PARTICIPANT NOTEBOOK)

OFFICE OF PAVEMENT TECHNOLOGY
FEDERAL HIGHWAY ADMINISTRATION
DEPARTMENT of TRANSPORTATION

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Participant Notebook

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CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

COURSE OBJECTIVES

- Provide Design/Construction Guidance for Pavement Subsurface Drainage Systems
- Emphasis on Video Inspection of Edgedrains for Quality Assurance
- Emphasis on the Need for Maintenance

WORKSHOP OVERVIEW

SESSION A

- DRAINAGE
- PCC PAVEMENT DISTRESS
- FLEXIBLE PAVEMENT DISTRESS
- MOISTURE REDUCTION PLAN

WORKSHOP OVERVIEW
(CONT.)

SESSION B
- PERMEABLE BASES
- PCC PAVEMENTS
- FLEXIBLE PAVEMENTS
- CONSTRUCTION TRAFFIC
- BASE MATERIALS

WORKSHOP OVERVIEW
(CONT.)

SESSION C
- UNSTABILIZED BASES

SESSION D
- STABILIZED BASES
- ASPHALT STABILIZED BASES
- CEMENT STABILIZED BASES

WORKSHOP OVERVIEW
(CONT.)

SESSION E
- DESIGN CONSIDERATIONS
- AGGREGATE SEPARATOR LAYER

SESSION F
- EDGEDRAINS

WORKSHOP OVERVIEW
(CONT.)

SESSION G
- OUTLET PIPE
- HEADWALLS
- ROADSIDE MAINTENANCE

SESSION H
- VIDEO INSPECTION
- MAINTENANCE

BACKGROUND

- FHWA field survey of ten states
  - Determined Design Criteria and Construction Problems for Permeable Bases
- Experimental Project No. 12 "Concrete Pavement Drainage Rehabilitation"
  - Investigate the Effects of Retrofit Edgedrains on PCC Pavements

BACKGROUND

- Demonstration Project No. 87 (Demo 87) "Drainable Pavement Systems"
  - Provided Drainage Guidance for PCC Pavements
- National Highway Institute (NHI) Course No. 130126 "Pavement Subsurface Drainage Design
  - Extended Drainage Horizons

CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

SESSION A

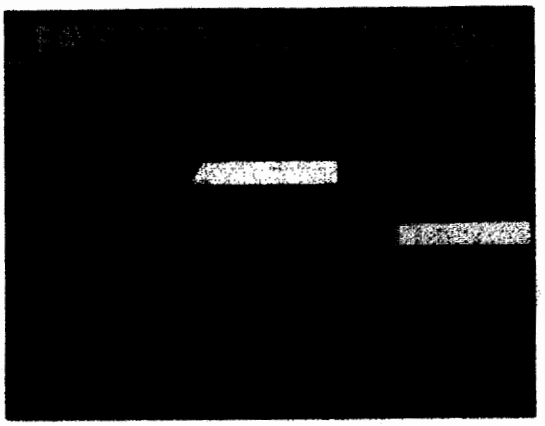
Drainage
PCC Pavement Distress
Flexible Pavement Distress
Moisture Reduction Plan

SESSION OBJECTIVES

- **Discuss Drainage of Pavements**
- **Explain PCC & Flexible Pavement Distress**
- **Discuss Moisture Reduction Plan**

Water in the Pavement Structure

Primary Cause of Distress



SOURCES of WATER

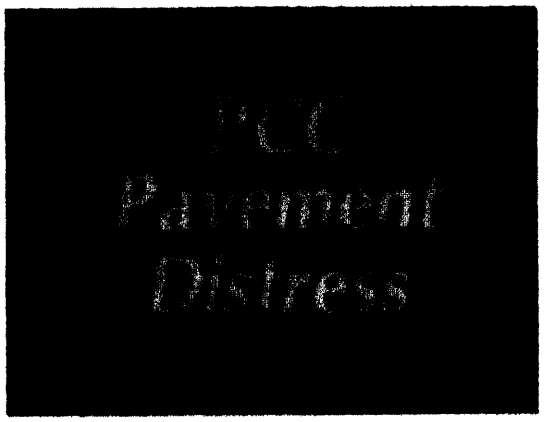
- Surface Infiltration
- Rising Groundwater
- Seepage
- Capillary Action
- Vapor Movement

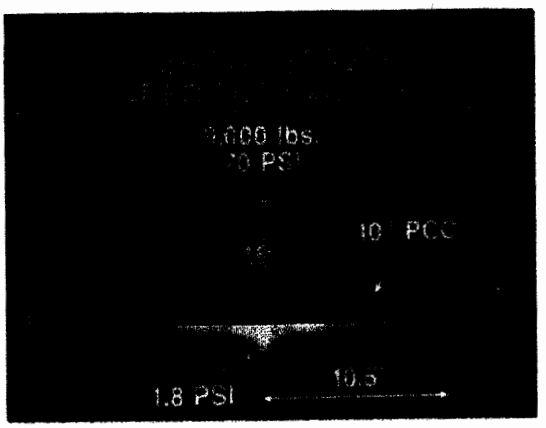
INFILTRATION RATIO

Asphalt Concrete	0.33 – 0.50
Portland Cement	0.50 – 0.67

Heavy Aggregate Truck

Jumbled Pavement Slabs



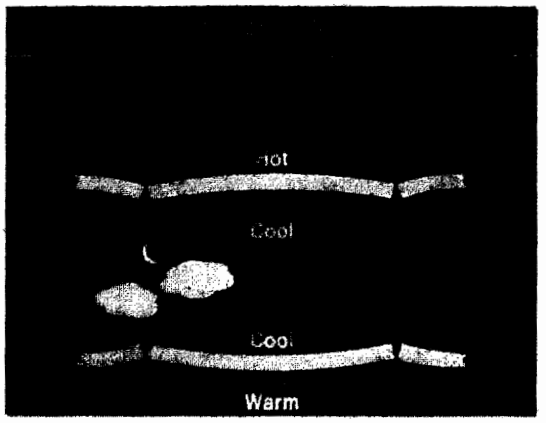


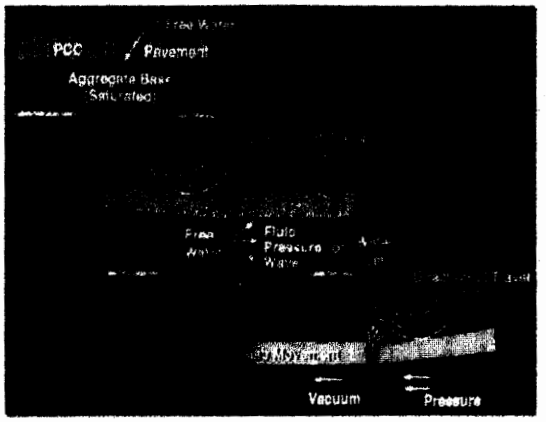
MOISTURE DISTRESS PCC PAVEMENT

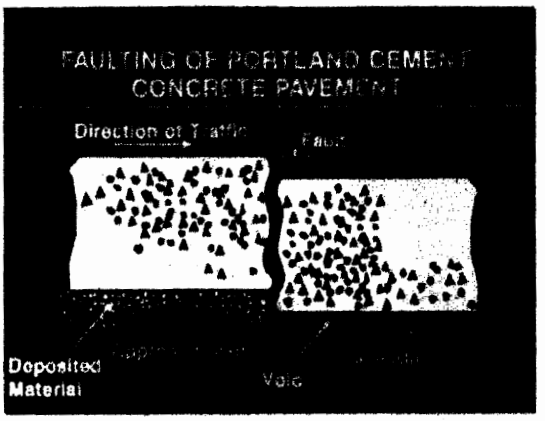
- Curling/warping
- Pumping
- Faulting
- Corner Breaks
- D-cracking
- Punchouts

FACTORS FOR PUMPING

- Free Water
- Heavy Wheel Loads
- Erodible Base
- Voids

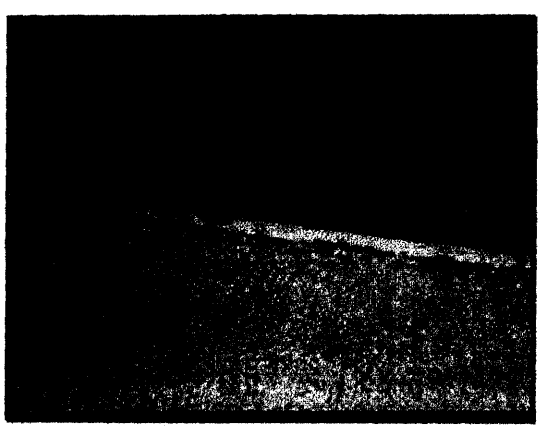

Hot
Cool
Cool
Warm


PCC
Pavement
Aggregate Base
Saturated
Fluid
Pressure
Water
Vacuum
Pressure


FAULTING OF PORTLAND CEMENT CONCRETE PAVEMENT
Direction of Traffic
Fault
Deposited Material
Void

Water Being Ejected

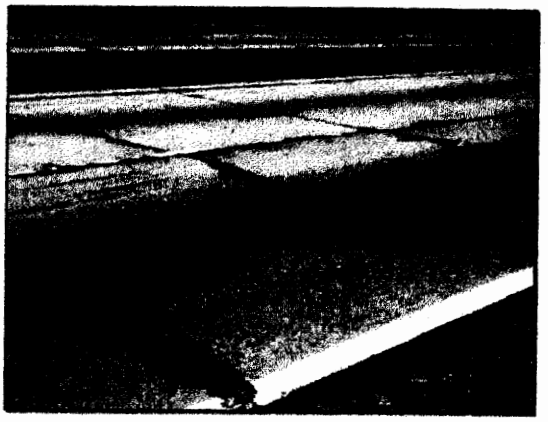
Faulting



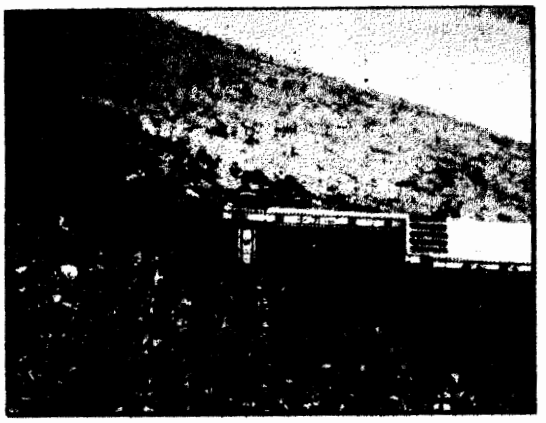
Classic Corner Break

Pumping Stains on Shoulder

Shoulder Breakup



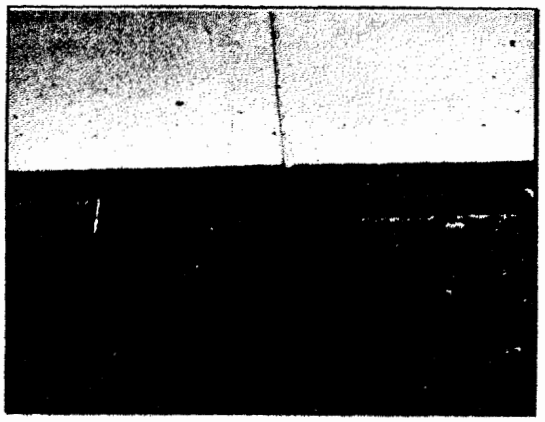
Total Pavement Failure



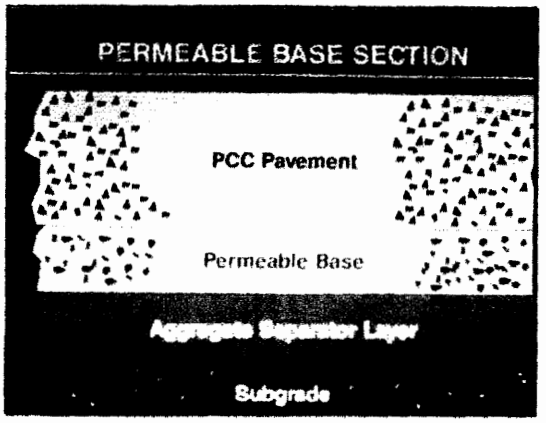
Opening of Pavement/Shoulder Joint

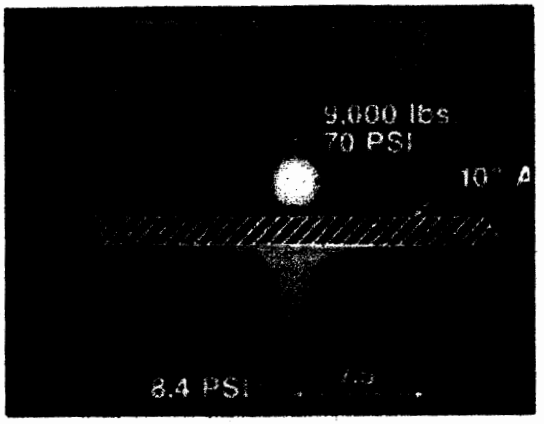
OTHER PCC PAVEMENT ELEMENTS

Tied Concrete Shoulders



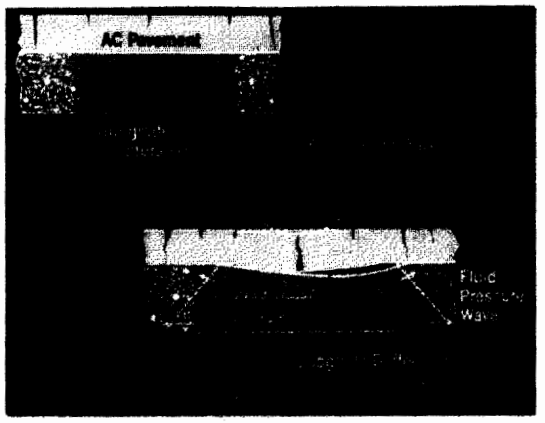
Dowel Bar Baskets

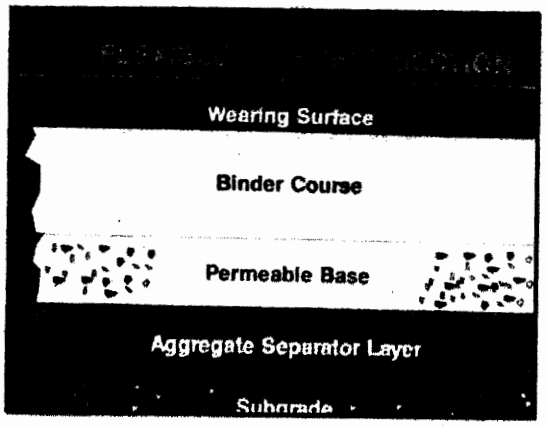




MOISTURE DISTRESS AC PAVEMENT

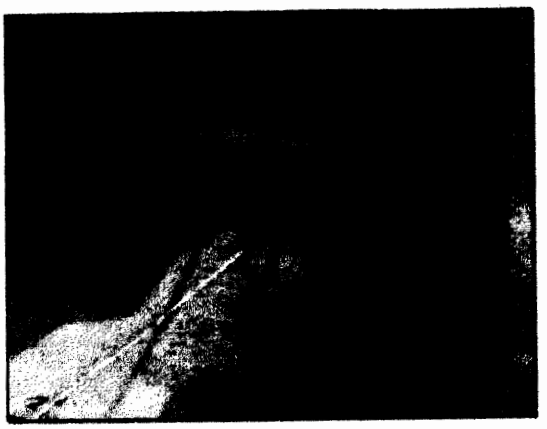
- Stripping
- Rutting
- Alligator or Fatigue Cracking
- Potholes
- Crack Deterioration





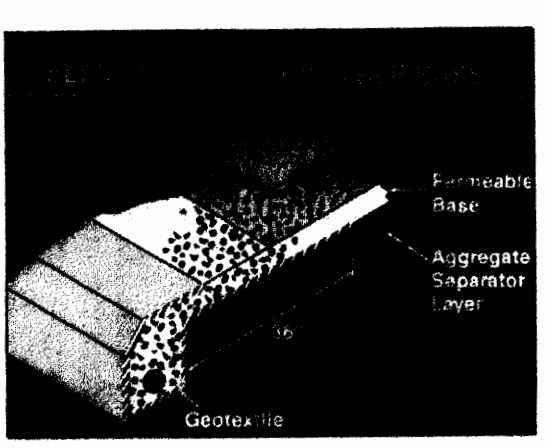
REMEDIAL MEASURES

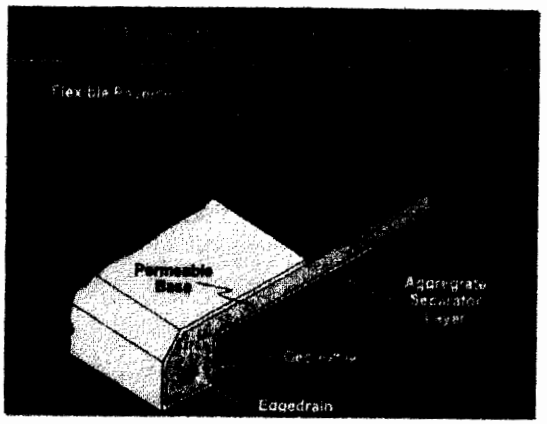
- Proper Sealing
- Adequate Drainage

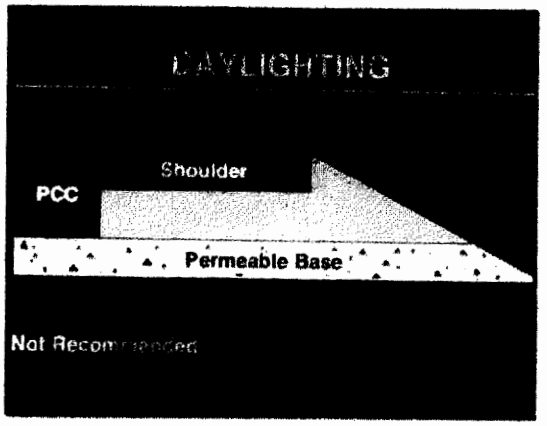


Sealing Cracks

SUMMARY







POSITIVE DRAINAGE

- Provide longitudinal edgedrain system with outlet pipe

DRAINABLE PAVEMENT SYSTEM ELEMENTS

- Permeable Base
- Separator Layer
- Edgedrain System

SUMMARY

- Drainage of Pavements
- PCC & Flexible Pavement Distress
- Moisture Reduction Plan

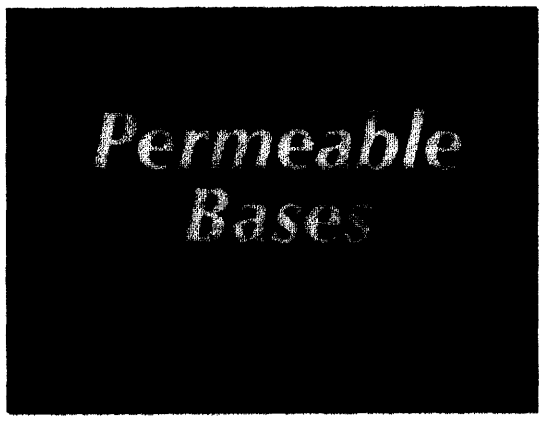
CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

SESSION B

Permeable Bases
PCC Pavements
Flexible Pavements
Construction Traffic
Base Materials

SESSION OBJECTIVES

- **Discuss Relationship of Edgedrains for PCC Pavements**
- **Discuss Relationship of Edgedrains for Flexible Pavements**
- **Explain Role of Construction Traffic**
- **Identify Importance of Good Aggregate Material**



PERMEABLE BASE FUNCTIONS

- Drainage
- Adequate Strength to Achieve Pavement Performance
- Stability During Construction Phase

STABILITY / PERMEABILITY RELATIONSHIP

- Stability
- Permeability

STABILITY

Stability is primarily determined by:

- Quality of Aggregates
- Particle Size and Distribution
- Stabilizer Material

PERMEABILITY

Permeability is primarily determined by:

- **Particle Size and Distribution**

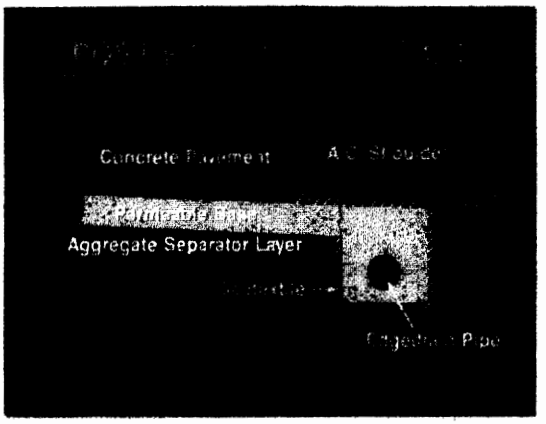
PAVEMENT SECTION

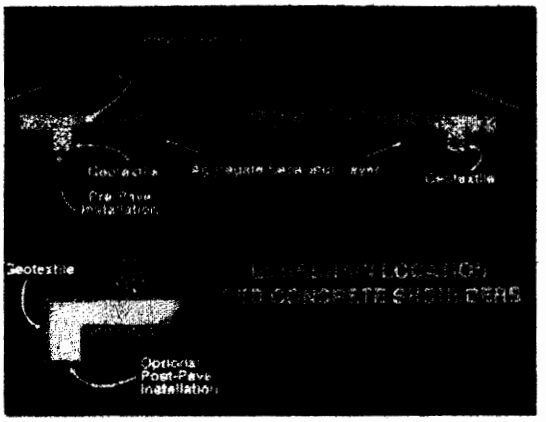
- **Material Type**
  - **–Unstabilized**
  - **–Stabilized**
- **Separator Layer Type**
  - **–Aggregate**
  - **–Geotextile**
- **Edgedrain Location**

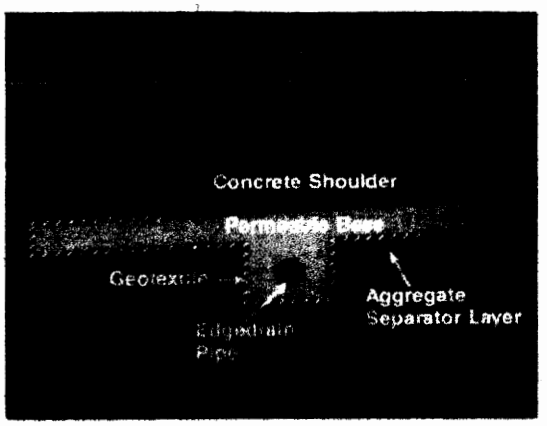
PAVEMENT SECTION

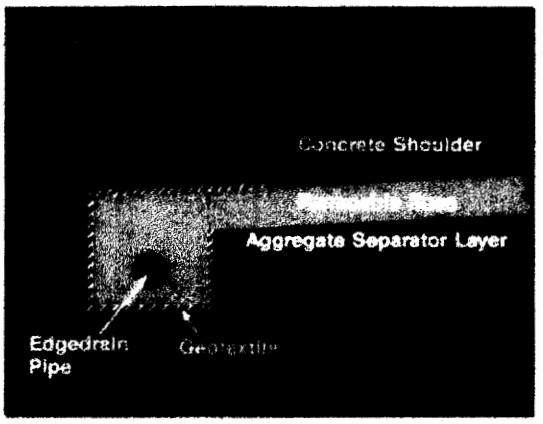
- **Edgedrain Installation**
  - **–Pre-**
  - **–Post-**
- **Pavement Cross Slope**
  - **–Uniform**
  - **–Crowned**
- **Shoulder Type**
  - **–Similar**
  - **–Dissimilar**

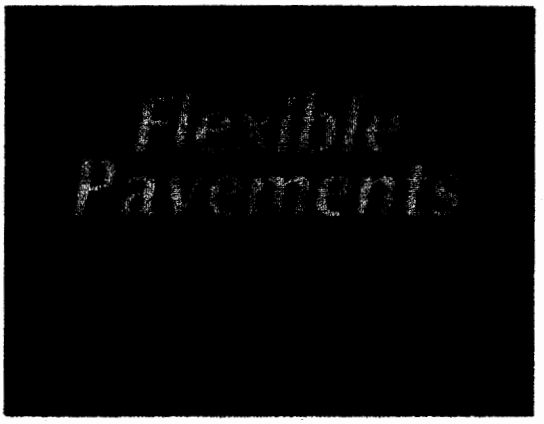

Permeable Base

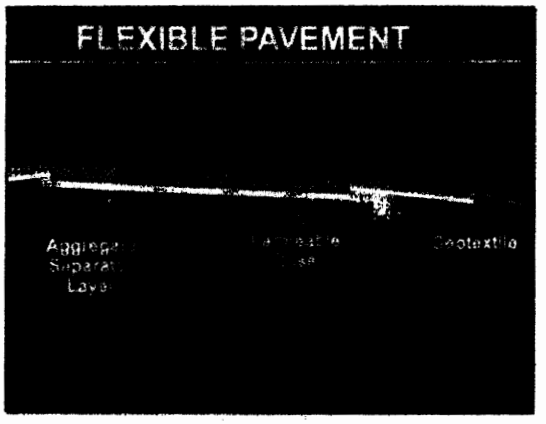

Aggregate Separator Layer

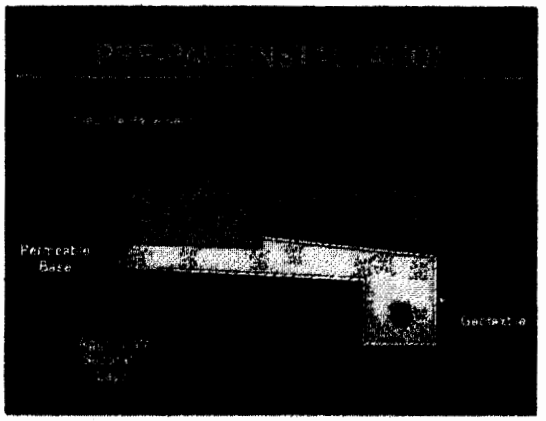

Geotextile
Optional
Post-Pave
Installation

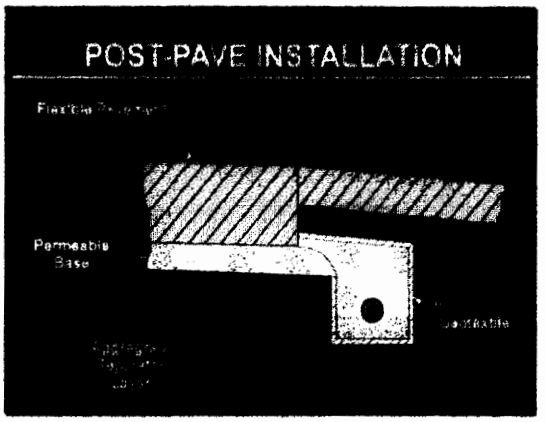

Concrete Shoulder
Aggregate
Separator Layer

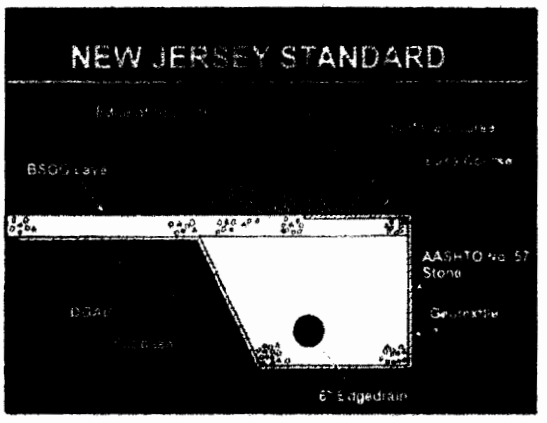

Concrete Shoulder
Aggregate Separator Layer
Edgedrain Pipe

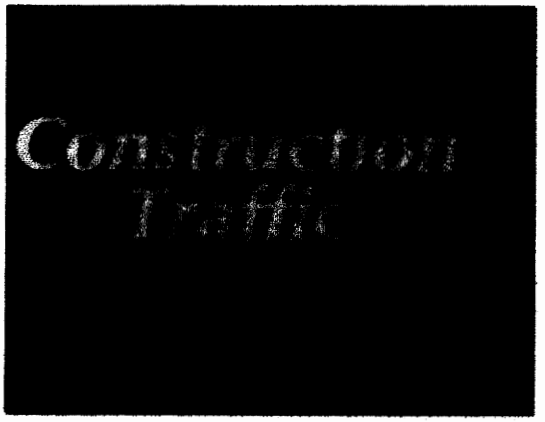

Flexible Pavements


FLEXIBLE PAVEMENT




POST-PAVE INSTALLATION
Permeable
Base

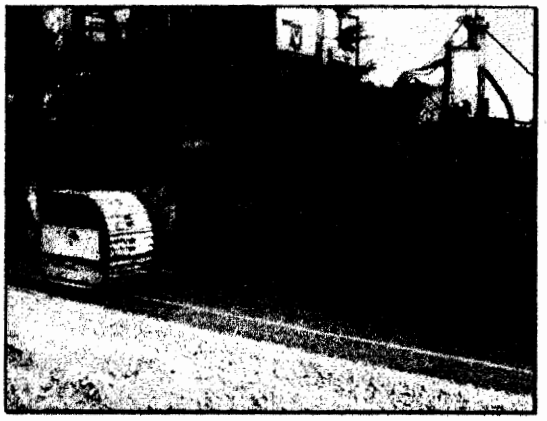

NEW JERSEY STANDARD
AASHTO No. 57
Stone



CONSTRUCTION TRAFFIC

Important factor in selecting type of permeable base

Dumping Concrete on Permeable Base



Placing PCC Pavement on Permeable Base

Delivery Trucks Running on Permeable Base

Dowel Baskets on Permeable Base

Dowel Bar Implanter

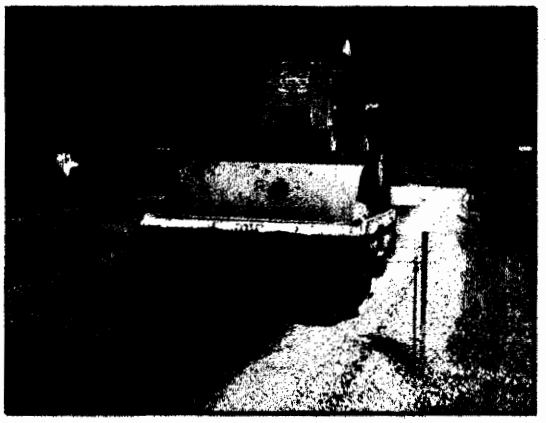
CONSTRUCTION TRAFFIC

None	**Unstabilized**
Moderate	**Unstabilized $C_U > 4$**
Heavy	**Asphalt or Cement Stabilized**

CONSTRUCTION TRAFFIC

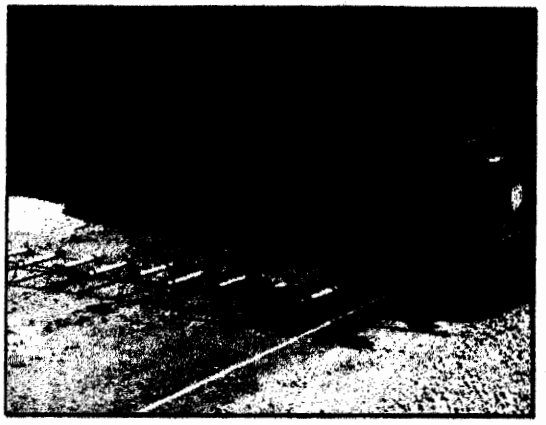
- **Keep Volume Down**
- **Keep Speed Down**
- **Gentle Turning**
- **Gentle Starting and Stopping**

Delivery Trucks on Permeable Base



Rolling Permeable Base Between Deliveries

Pinning Dowel Bar Baskets



Paver Approaching Dowel Bars

Stringline Control

Delivery Trucks Directly on Permeable Base

Placing Concrete

Dowel Bars Should Not Move

No Noticeable Displacement of Permeable Base by Paving Operation

PERMEABLE BASE MATERIAL

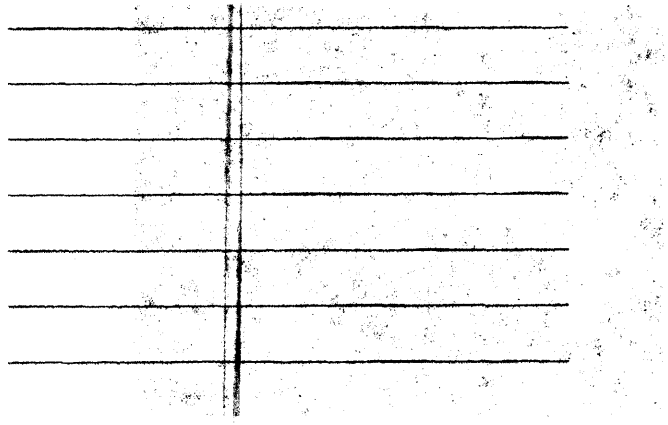
- Durable
- Angular
- Crushed – 2 Faces
- Aggregate Interlock

L.A. ABRASION WEAR

- L.A. Abrasion Wear Not to Exceed 45 Percent
- Los Angeles Machine
- AASHTO T 96 - 94

SOUNDNESS

- Sodium Sulfate 12%
- Magnesium Sulfate 18%
- Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- AASHTO T 104 - 97



PLASTICITY

- Plasticity is the property of a soil that allows it to be deformed beyond the point of recovery without cracking or appreciable volume change

PLASTICITY

- Material Passing No. 40 Sieve (0.425 mm)
- Determining the Plastic Limit and Plasticity Index of Soils
- AASHTO T 90 - 96

PLASTICITY

Aggregate Material should be Non-Plastic

PARTICLE SIZE

- **Particle Size – D_{XX} = 1.91 mm**
- **"xx" – Represents the Percent Smaller**
- **D_{10} = 1.91 mm – 10 Percent of the Material Will Be Smaller than 1.91 mm**

EFFECTIVE SIZE (D_{10})

Effective size (D_{10}) is the opening size in millimeters, in which 10% of the material will pass.

$$C_U = \frac{D_{60}}{D_{10}}$$

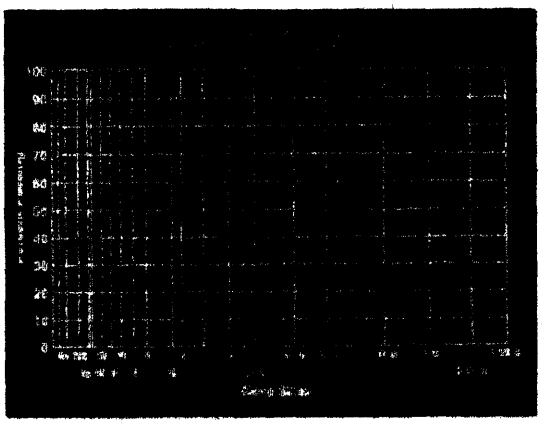
Where:

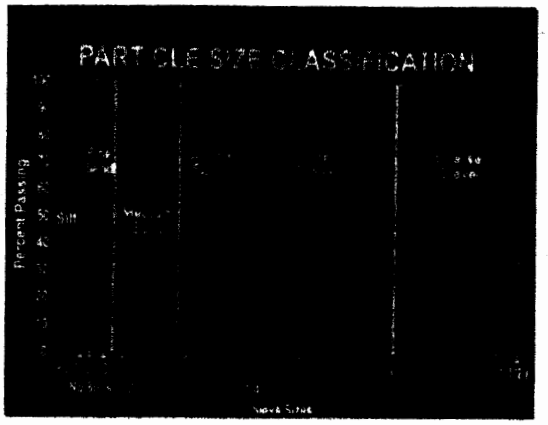
D_{60} = Particle Size, mm (60 percent passing)

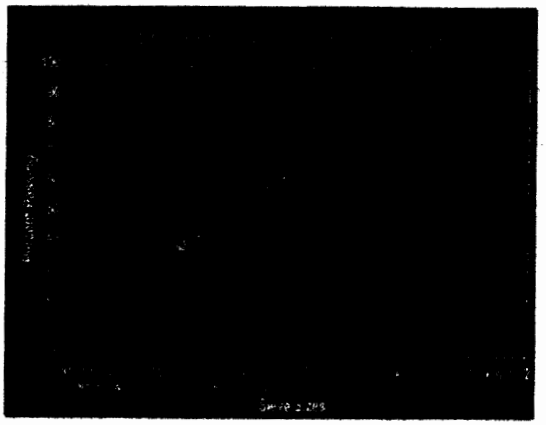
D_{10} = Particle Size, mm (10 percent passing)

COEFFICIENT OF UNIFORMITY (C_U)

Coefficient of Uniformity (C_U) is an indicator of the spread of particle grain size

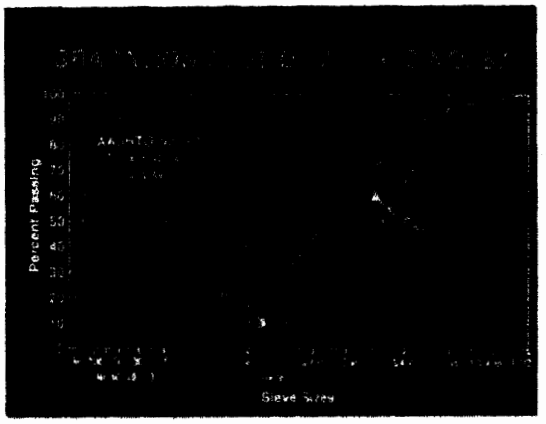


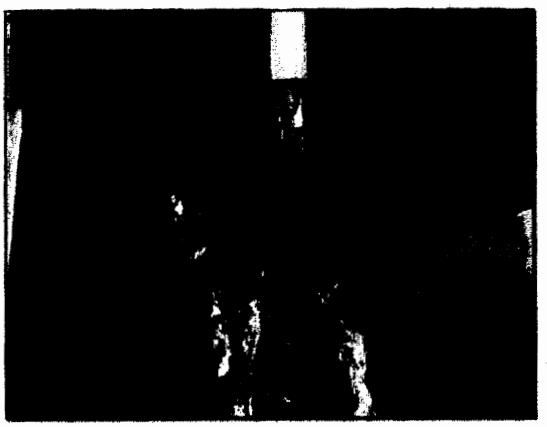




AASHTO No. 57

Sieve Size	Percent Passing
1-1/2"	100
1"	95 – 100
l/2"	25 – 60
No. 4	0 – 10
No. 8	0 - 5





Permeability Demonstration

PERMEABILITY (k)

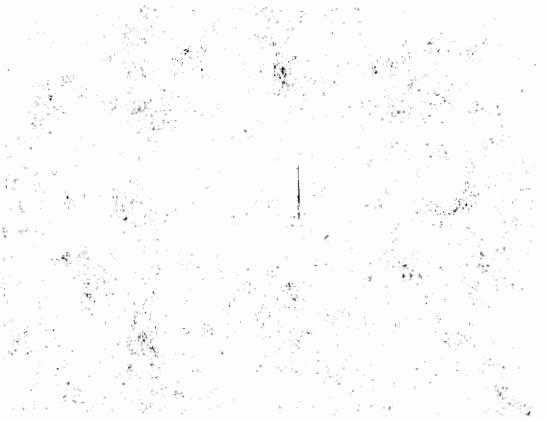
Coefficient of Permeability (k) should be greater than 1000 feet/day

TYPES OF PERMEABLE BASES

- Unstabilized
- Stabilized

SUMMARY

- Relationship of Edgedrains for PCC Pavements
- Relationship of Edgedrains for Flexible Pavements
- Construction Traffic – Important Factor
- Use Good Aggregate Materials



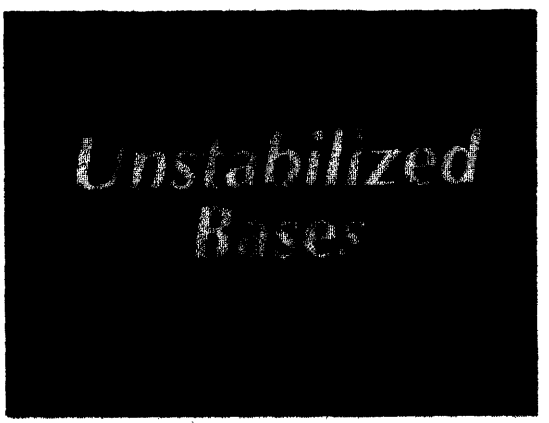
CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

SESSION C

Unstabilized Permeable Bases

SESSION OBJECTIVES

- **Provide Design/Construction Guidance**
- **Explain the Need for Good Quality Aggregate Material**
- **Discuss Sound Construction Practices**



UNSTABILIZED BASES

- More Finer Material
- Mechanical Interlock of Aggregates

CRUSHED STONE

FHWA recommends that only crushed stone material be used in permeable bases

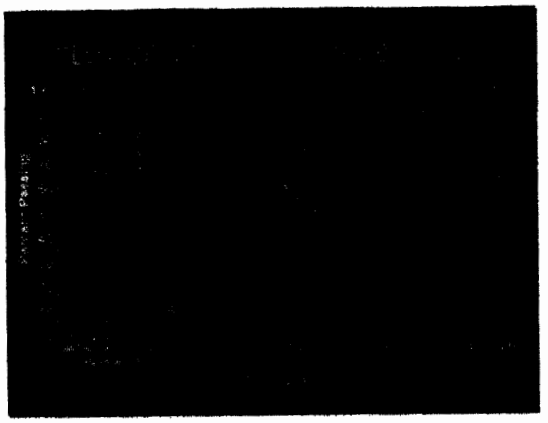
Stone Quarry – Good Aggregate Material

COEFFICIENT OF UNIFORMITY (C_U)

- C_U Greater than 4

UNTREATED PERMEABLE BASE
New Jersey Gradation

Sieve Size	Percent Passing
1-1/2"	100
1"	95 – 100
1/2"	60 – 80
No.4	40 – 55
No.8	5 – 25
No. 16	0 – 8
No. 50	0 – 5



Placing & Compacting Unstabilized Bases

UNSTABILIZED BASE COMPACTION

- 1 to 3 passes of 5-10 ton steel wheel roller

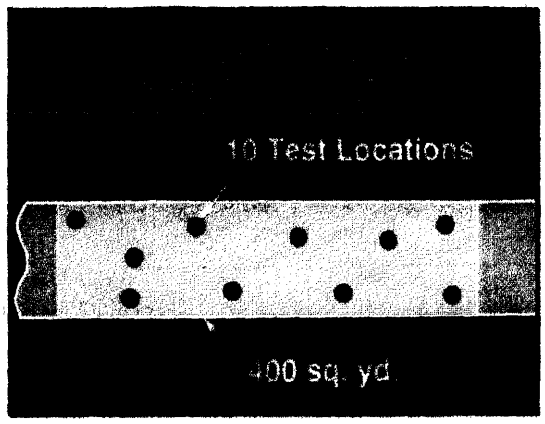
  or

- Vibratory roller with care

AVERAGE REFERENCE DENSITY

- Control Section 400 sq. yd.
- Maximum Density
  - Nuclear Density Test
  - Aggregate Crushing

Nuclear Density Gauge Determines Density

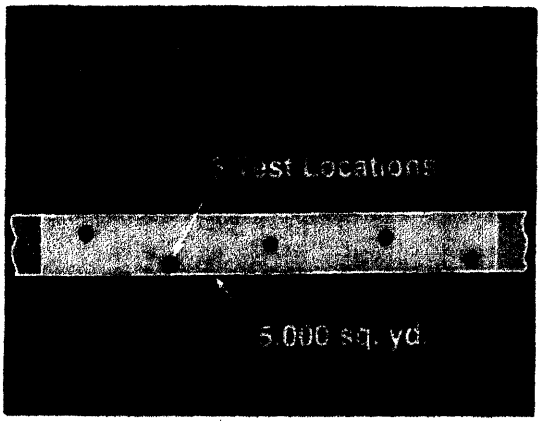


AVERAGE REFERENCE DENSITY

- **Average In-Place Density of Control Strip Based on 10 Tests**

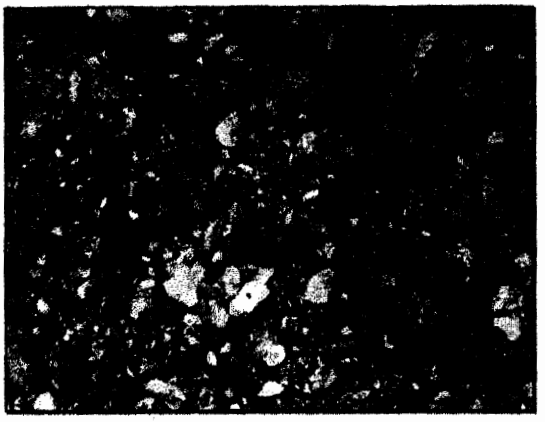
IN-PLACE DENSITY

- Determined by Nuclear Density
- Density of Soil and Soil Aggregate In-Place by Nuclear Methods
- AASHTO T 238-97



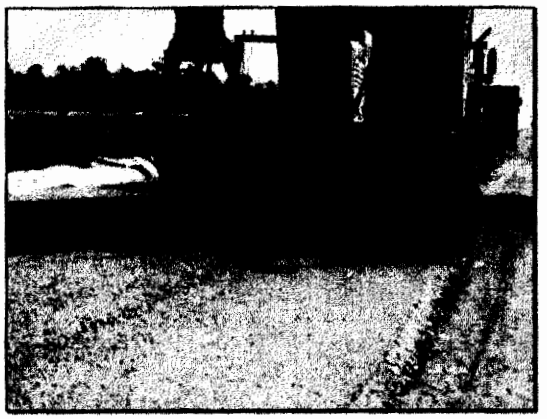
AVERAGE IN-PLACE DENSITY

- Lot Size – 5,000 sq. yd.
- Random Tests – 5 Locations
- Average In-Place Density
- Not less than 95% of reference density

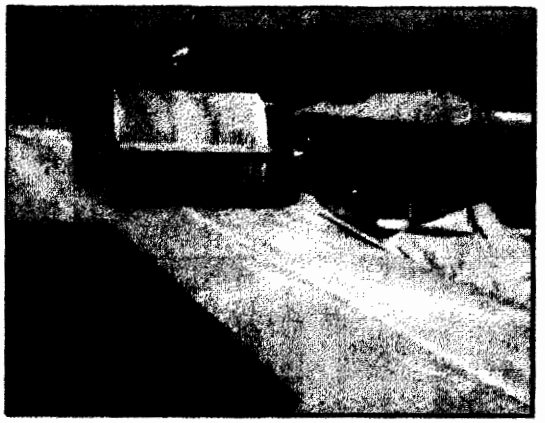


New Jersey Unstabilized Open-Graded Permeable Base

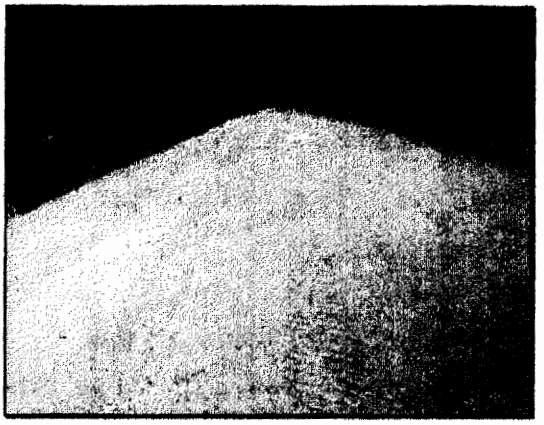
Placing Permeable Material



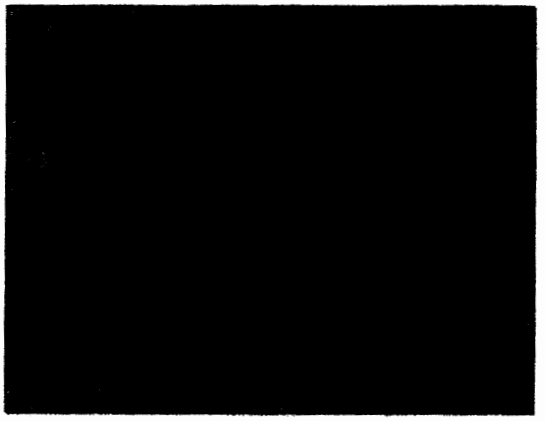
Spreading Permeable Material



Compacting Permeable Base

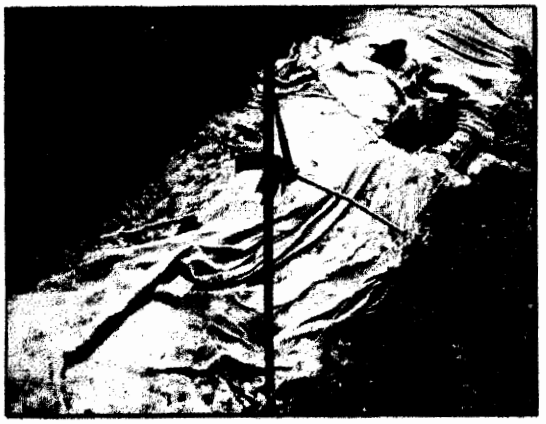


Completed Unstabilized Permeable Base



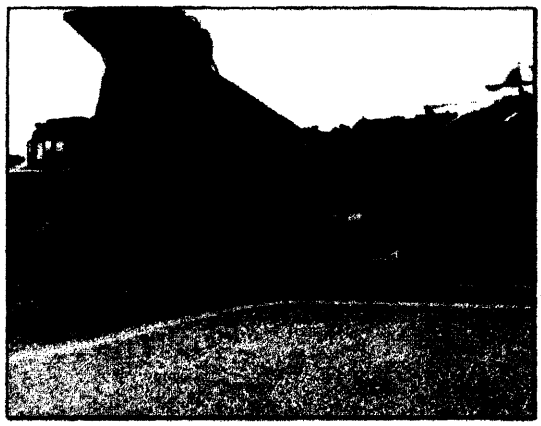
Close-up shows "Openness" of Completed Permeable Back

Asphalt Paver Used to Place Unstabilized Permeable Base



Stringline Provides Grade & Alignment Control

Paver Spans Permeable Base



Side Delivery of Concrete

Paver Tracks Run on DGAB

Completed Unstabilized Permeable Base

SUMMARY

- Design/Construction Guidance Provided
- Use Good Quality Aggregate Material
- Use Sound Construction Practices
- Guideline Specifications for Unstabilized Permeable Bases Provided in Appendix

CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

SESSION D

Stabilized Bases
Asphalt Stabilized Bases
Cement Stabilized Bases

SESSION OBJECTIVES

- Provide Design/Construction Guidance
- Explain the Need for Good Quality Aggregate Material
- Discuss Sound Construction Practices

STABILIZED BASES

- More open-grade material
- Cementing action of stabilized material at points of aggregate contact

PRIMARY PURPOSE

Increase structural strength of the pavement section

SECONDARY PURPOSE

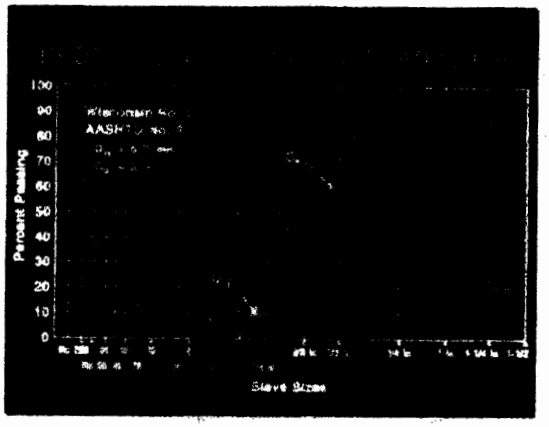
Provide stability of the permeable base during the construction phase

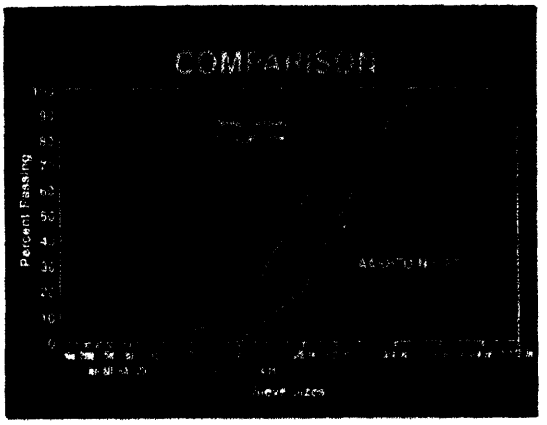
STABILZER MATERIAL

Contractor may have the option of providing type of stabilizer

AASHTO No. 67 GRADATION

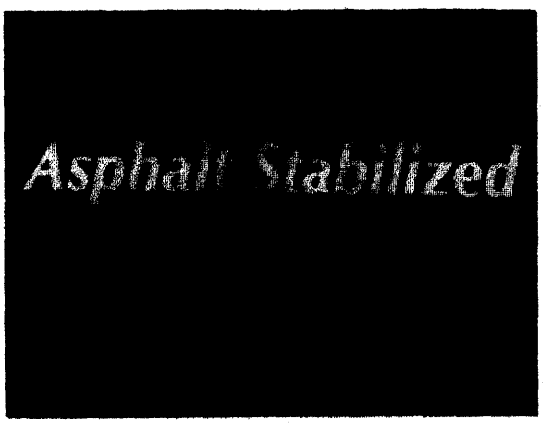
Sieve Size	Percent Passing
1-1/2"	100
3 /4"	90 – 100
3/8"	20 – 55
No. 4	0 – 10
No.8	0 – 5





STABILIZATION

Stabilization is not a substitute for good quality aggregates



MP1 98 PERFORMANCE GRADED

PG XX –YY

- XX – 7 Day Average Maximum Temperature + ^{0}C
- YY – 7 Day Average Minimum Temperature - ^{0}C

MP1 98 EXAMPLE

PG 58 –22

- 58 – 7 Day Average Maximum Temperature + ^{0}C
- -22 – 7 Day Average Minimum Temperature - ^{0}C

MP1 98 PERFORMANCE GRADED

- Asphalt Grade Should Be Determined by Pavement Engineer Using Superpave Software
- PG 76 – 22 or 76 - 16

ASPHALT CONTENT

- 3 Percent

ANTI-STRIPPING AGENT

- FHWA strongly recommends the use of a Anti-Stripping agent

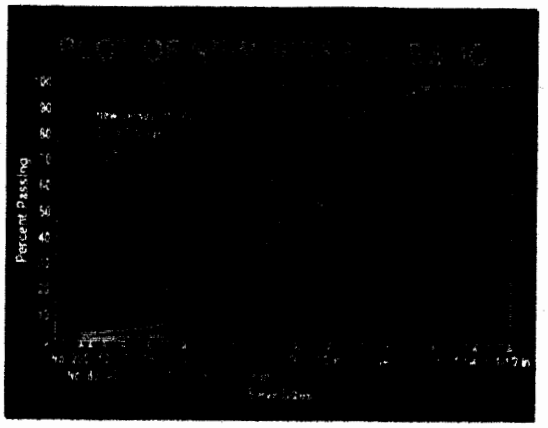
ASPHALT STABILIZED GRADATIONS

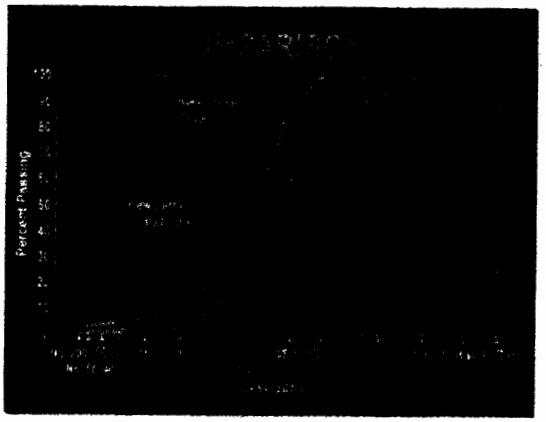
- Most SHA's use an AASHTO No. 57 or 67 gradation with asphalt stabilization

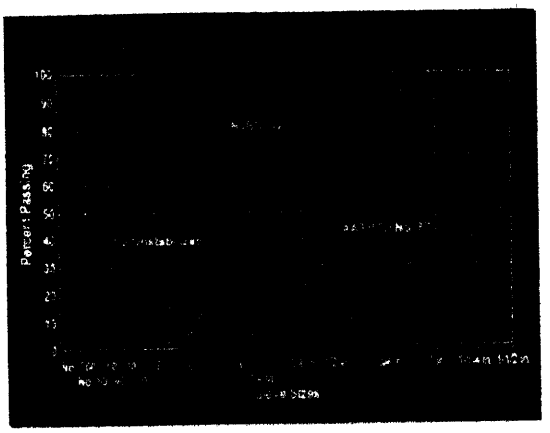
NEW JERSEY BSOG

Sieve Sieve	Percent Passing
1"	100
3/4""	95 – 100
l/2"	85 – 100
3/8"	60 – 90
No.4	15 – 25
No.8	2 – 10
No.16	2 – 5
No. 200	*

* Add 2% mineral filler







Placing & Compacting Asphalt Stabilized Bases

PRE-HEAT AGGREGATES

- Aggregates should be heated to 275 – 325^0 F

HOPPER TEMPERATURE

200 – 250^0 F

Checking Temperature of the Asphalt Mat

COMPACTION TEMPERATURE

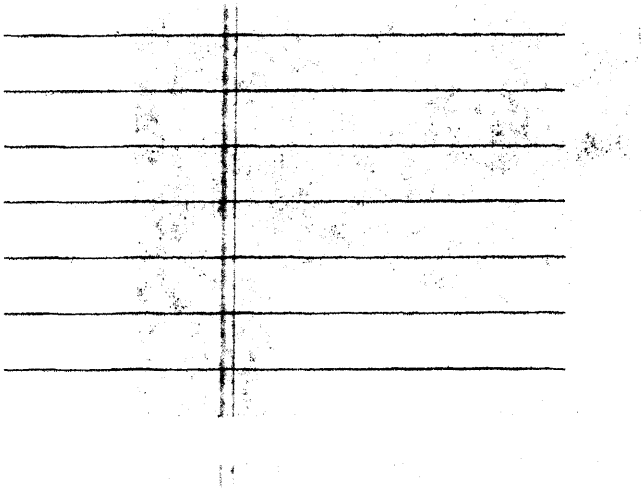
- **Cool to 150^0 F**
- **Finish Before 100^0 F**

COMPACTION OF ASPHALT STABILIZED BASE

- 1 to 3 passes of 5-10 ton steel wheel roller
- No vibratory rollers

IN-PLACE DENSITY

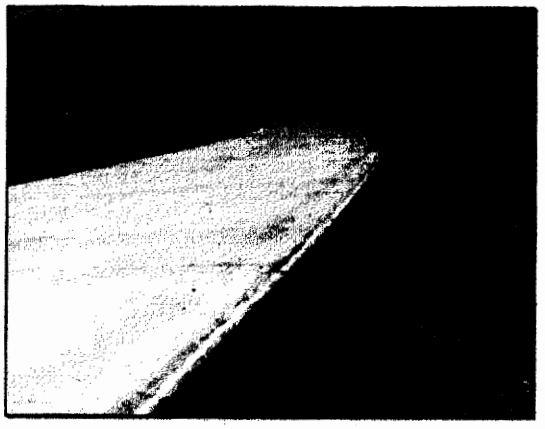
- AASHTO T 191-93 Sand Cone Method
- AASHTO T 205-86 Rubber Balloon Method
- AASHTO T 238-97 Nuclear Methods



RESTRICTING TRAFFIC

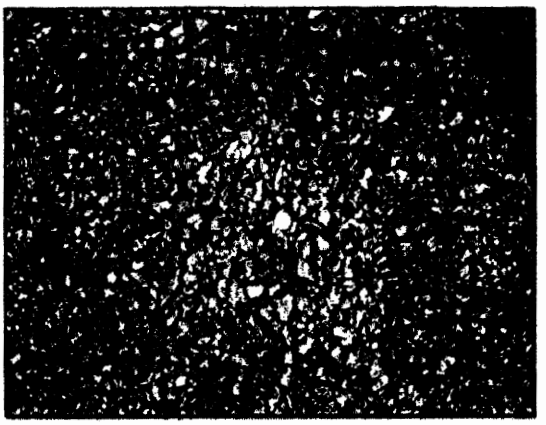
Restrict traffic on ASPM bases for at least 1 day

Elements of an Asphalt Stabilized Permeable Base



Geotextile Will Be folded over Edgedrain

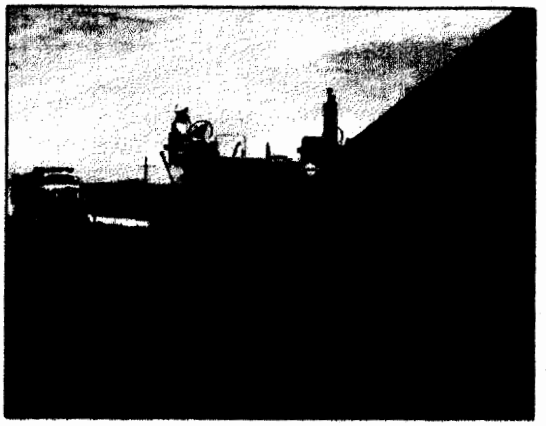
Continue Compaction Past End of Day's Paving



Note "Openness" of Completed Asphalt Stabilized Permeable Base

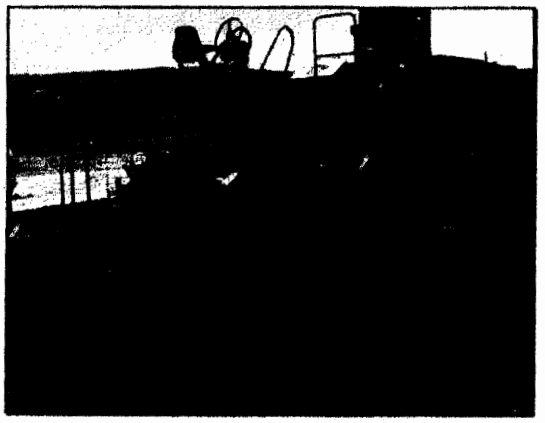
Field Permeability Test – Dumping Water

Discharging Water



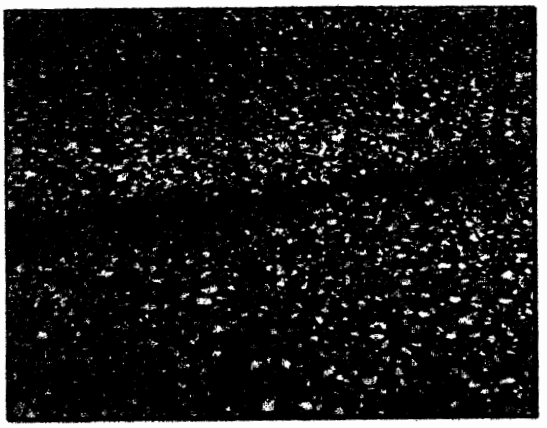
Placing Asphalt Stabilized Material

Asphalt Paver Placing Permeable Base

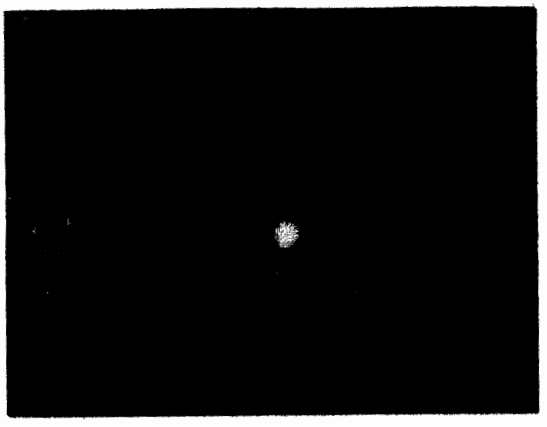


Spreading Asphalt Stabilized Material

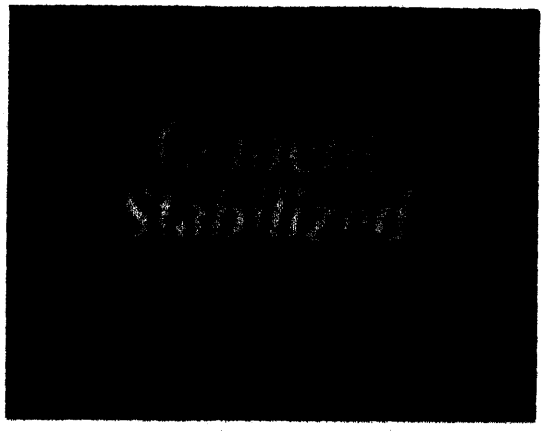
Compacting Asphalt Stabilized Material



View of Rolldown



Completed Asphalt Permeable Base



TYPE OF CEMENT

- Types I, I-P, or II
- Portland Cement
- ASTM C 150-97

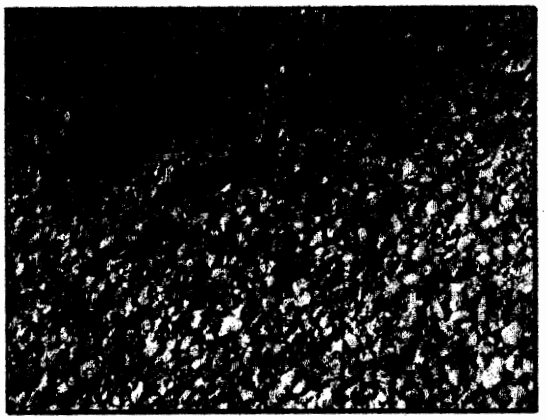
CEMENT TREATED

Portland Cement 2 to 3 bags per cu. yd.

CEMENT STABILIZED GRADATIONS

- Most SHA's use an AASHTO No. 57 or 67 gradation with cement stabilization

Test Cylinder



Close-up of Completed Cement Stabilized Permeable Base

Placing & Compacting Cement Stabilized Bases

COMPACTION OF CEMENT STABILIZED BASE

Vibratory screeds set base material

Vibratory Screeds "Seat" Permeable Material

CURING

- Polyethylene Sheeting
- Fine Mist Curing
- Curing Compound

Placing Plastic Sheeting

Securing Sheeting from Wind

Dirt & Sheeting Must Be Removed

SHEETING

Minimum of 3 Days Coverage

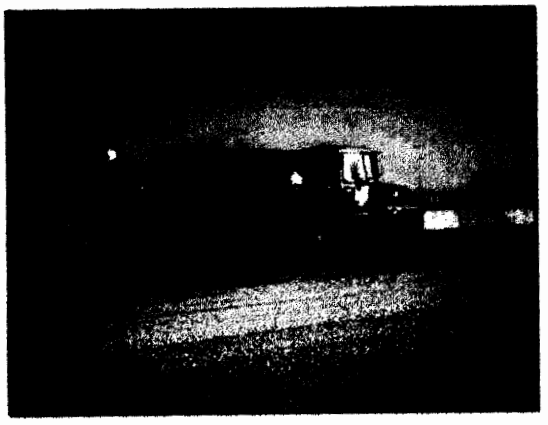
Fine Mist Spray of Water

FINE MIST CURING

- Fine Mist cure every 2 hours for 8 hours
- Start curing the next day

CURING COMPOUND

- 1 gal. per 16.5 sq. yd.
- Liquid Membrane
- ASTM C 309-94

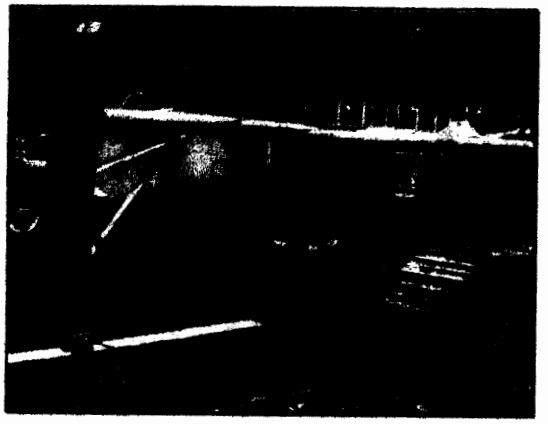


Spraying Asphalt Emulsion

RESTRICTING TRAFFIC

- Restrict traffic on CSPM bases for 7 days

Comparison of Gradations



Concrete Paver Used to Spread Cement Stabilized Material

Heavy Augers Required to Spread "Harsh" Mix

Resists Foot Traffic

Paver Track Marks on Permeable Base

Vibratory Plate Used to Eliminate Marks

Field Permeability Test – Spraying Water

Permeable Base Discharging Water

Storm Water Runoff Must Be Considered During Construction Phase

Only Slightly Damp

SUMMARY

- Design/Construction Guidance Provided
- Use Good Quality Aggregate Material
- Use Sound Construction Practices
- Guideline Specifications for Asphalt & Cement Stabilized Bases Are Provided in Appendix

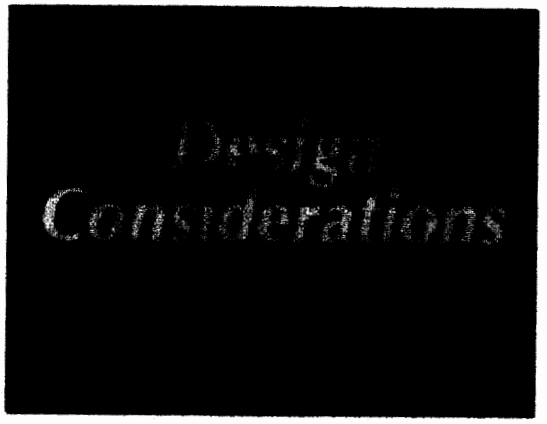
CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

SESSION E

Design Considerations
Aggregate Separator Layer

SESSION OBJECTIVES

- Provide Design/Construction Guidance
- Discuss Design Considerations for Permeable Bases
- Explain the Need for Good Quality Aggregate Material Discuss
- Discuss Sound Construction Practices



CONTROL STRIP

- FHWA recommends use of a control strip
- Test combination of aggregate materials and construction practices

CONTROL STRIP

- Minimum Length – 500 ft.
- Becomes part of finished roadway (if acceptable)

CONSTRIUCTION CONSIDERATIONS

- Quality
  - –Aggregate
  - –Construction
- Proper Application Rates
- Tracked Pavers
- Difficult to Trim Surface

CONSTRUCTION CONSIDERATIONS

- Compaction
- Construction Traffic
- Maintain Minimum Slope
- Incentive/ Disincentive Ride Requirements

PERMEABLE BASE THICKNESS

- Minimum Thickness – 4 inches
- Based on Construction Considerations

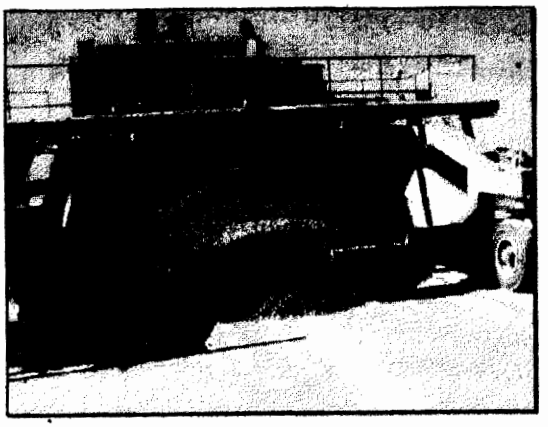
THICKNESS

Pavement drainage is not a substitute for pavement thickness or a strong subgrade

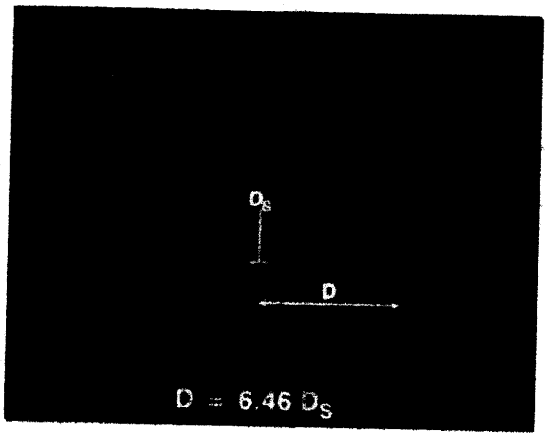
Aggregate Separator Layer

AGGREGATE SEPARATOR LAYER

- Stability
- Filtration
- Permeability

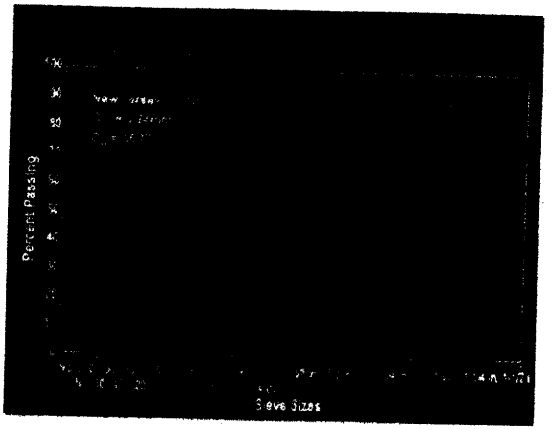


Placing Aggregate Separator Layer



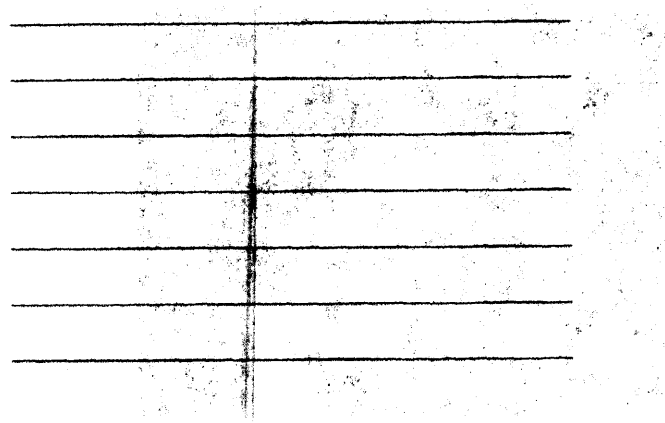
NEW JERSEY DGAB

Sieve Size	Percent Passing
1-1/2"	100
3 /4"	55 – 90
No. 4	25 – 60
No. 50	5 – 25
No. 200	3 – 12



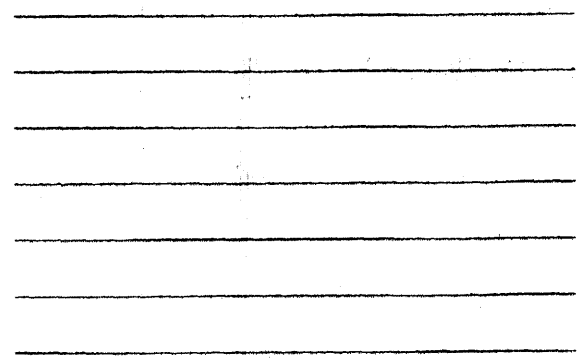
AGGREGATE SEPARATOR LAYER

- Class C Aggregate
- AASHTO M 283 – 83
- L.A. Abrasion Wear Not to Exceed 50 Percent

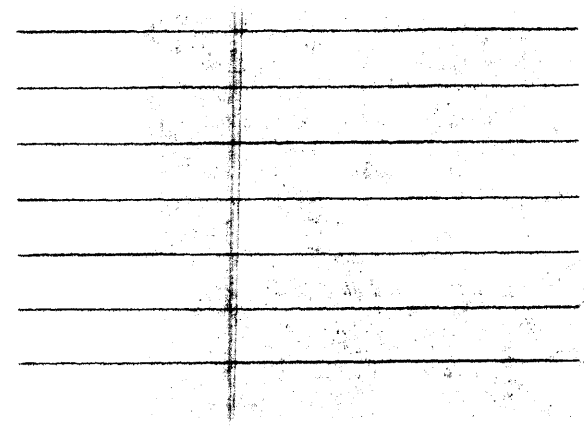


SOUNDNESS

- AASHTO T 104-97
- Sodium Sulfate - 12%
- Magnesium Sulfate - 18%



Placing & Compacting Aggregate Separator Layer



COMPACTION

- 95 Percent Maximum Density
- The Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in) Drop
- AASHTO T 180 - 97

IN-PLACE DENSITY

- AASHTO T 191 – 93 Sand Cone Method
- AASHTO T 205 – 86 Rubber – Balloon Method
- AASHTO T 238 – 97 Nuclear Methods

LAYER THICKNESS

Minimum Thickness - 4 Inches

Based on Construction Considerations

CONSTRUCTION CONSIDERATIONS

- Quality of Aggregates
- Compaction

SEPARATOR LAYER SUMMARY

- Required to keep fines from migrating into permeable base
- Recommend dense graded aggregate base

SUMMARY

- Design Considerations for Aggregate Separator Layer
- Design/Construction Guidance Provided
- Use Good Quality Aggregate Material
- Use Sound Construction Practices
- Guideline Specifications for Aggregate Separator Layer in Appendix

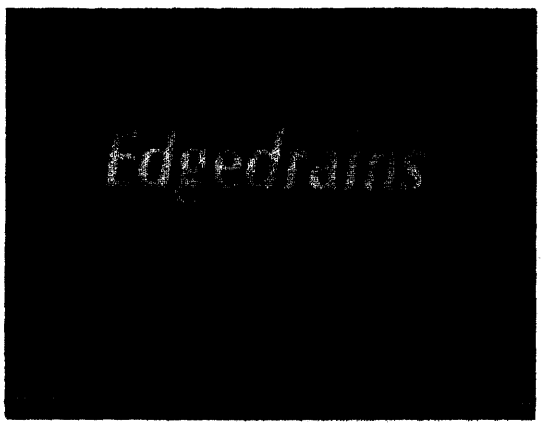
CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

SESSION F

Edgedrains

SESSION OBJECTIVES

- Provide Design/Construction Guidance
- Discuss the Need for Adequate Strength Pipe & Geocomposites, and Dual Outlets
- Explain the Need for the System to be Intact after Construction Phase



TYPES OF EDGEDRAINS

- Aggregate Trench
- Conventional Pipe
- Geocomposite Fin Drains

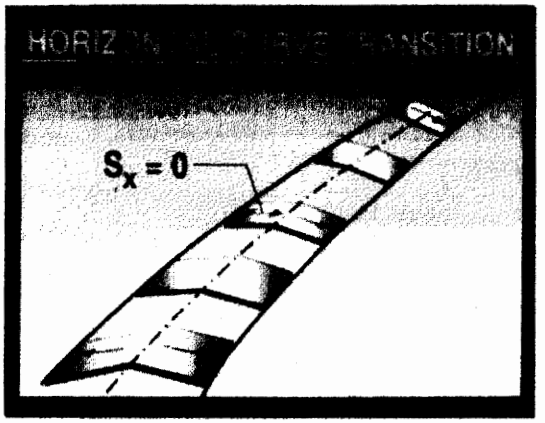
DEFINITIONS

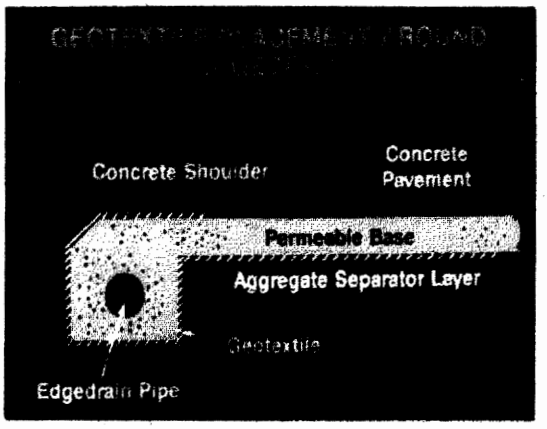
- Edgedrains –
  Pipe Systems Parallel to Roadway
- Underdrains –
  Everything else

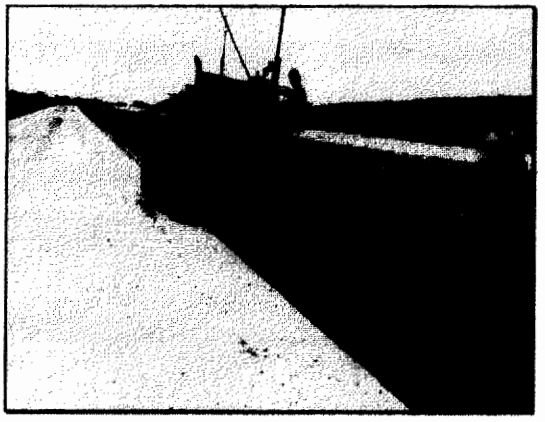
PROBLEM SLOPES

- Sag Vertical Curves $S = 0$
- Horizontal Curve Transitions
  $S_X = 0$

Level Roadway $S = 0$







Laying Geotextile Fabric

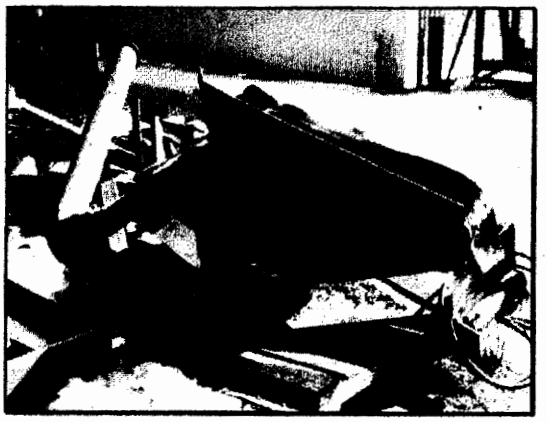
Fabric Installed

Laying Flexible Plastic Pipe

Pipe Installed

Backfilling Edgedrain Trench

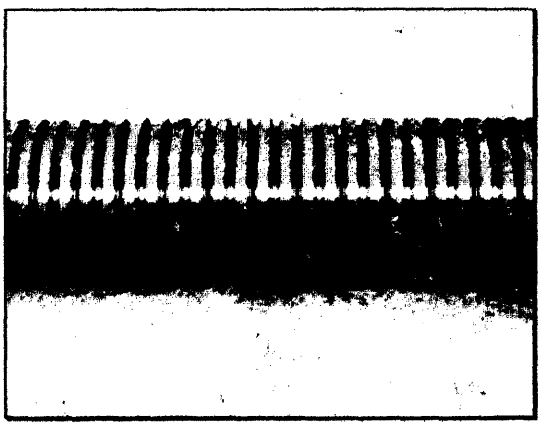
Placing Pipe with a Sleeve Arrangement



Sleeve Arrangement at Rest

CORRUGATED POLYETHYLENE PIPE (CPE)

- Corrugated Polyethylene Drainage Pipe
- AASHTO M 252



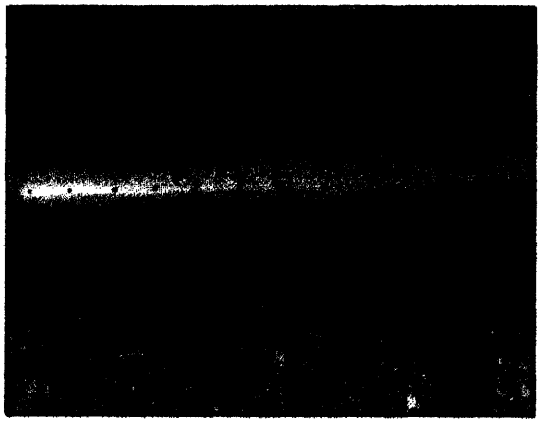
CPE Pipe with Slots

SMOOTH INTERIOR CPE PIPE

- Corrugated Polyethylene Drainage Pipe
- AASHTO M 252 - Type SP

POLYVINYL CHLOPIDE PIPE (PVC)

- Class PS 46 Polyvinyl Chloride (PVC) Pipe
- AASHTO M 278



PVC Pipe with Openings

CORRUGATED-SMOOTH PIPE

- PVC Corrugated Sewer Pipe with a Smooth Interior
- ASTM F 949

ASTM TRENCH BACKFILL

Edgedrain pipe should be capable or resisting ASPM

HEAT RESISTANT PIPE

- PVC 90^0 C Electric Plastic Conduit
- EPC-40 or EPC-80
- NEMA Specification TC-2

PIPE OPENINGS

- Pipes should have 2 square inches of openings per linear foot of pipe

TRENCH BACKFILL

- **Pre-pave installation - Should be the same material as the permeable base**
- **Post-pave installation - Should be as permeable as the permeable base**

TRENCH WIDTH

- **Wide enough to allow proper placement and compaction of backfill around pipe**

TRENCH DEPTH

- **Deep enough to accomplish intended drainage function**
- **Recommended depth – Top of pipe 2 inches below bottom of permeable base**

PIPE INSTALLATION

Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications

ASTM D 2321

FLORIDA DRAINCRETE

- AASHTO No. 89 Gradation
- 4 Bags of Cement per Cu. Yd.
- W/C Ratio < 0.40
- Compressive Strength 800 – 1500 psi

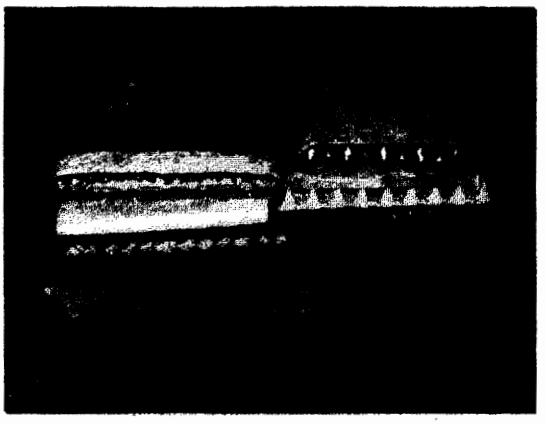
AASHTO No. 89 GRADATION

Sieve Size	Percent Passing
1/2"	100
3/8"	90 – 100
No.4	20 – 55
No. 8	5 – 30
No. 16	0 – 10
No. 50	0 – 5

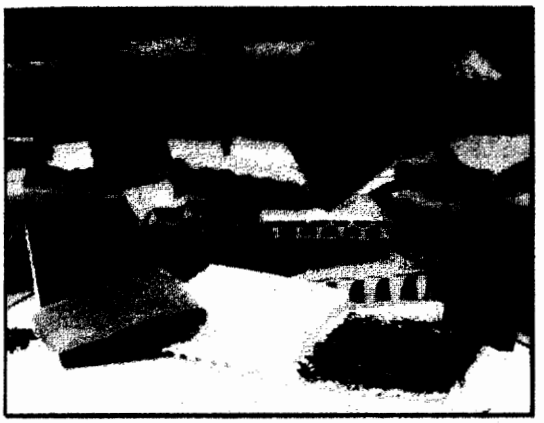
Placing Florida "Draincrete"

Clogged Edgedrain – No Geotextile

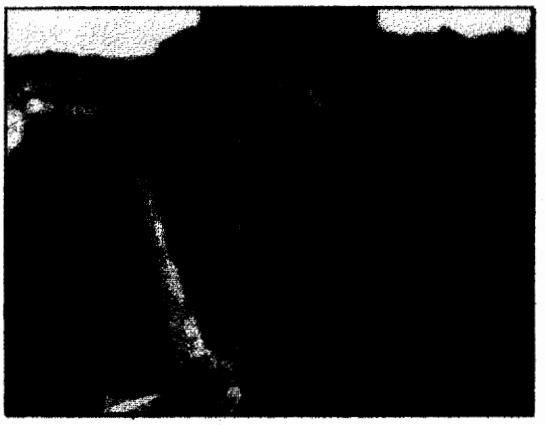
Clogged Edgedrain – No Geotextile



Pile of Geocomposites



Another Pile

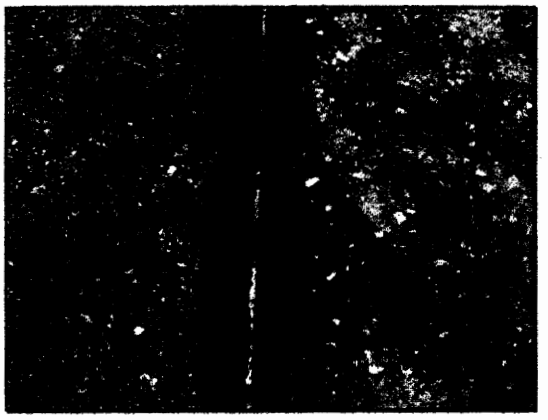


Typical Geocomposite Section

Installing Geocomposite Edgedrain

Wheel Cutter

Shoe Aligns Geocomposite in the Trench
Scrapper Backfills Trench



Geocomposite Installed

GEOCOMPOSITE ELEMENTS

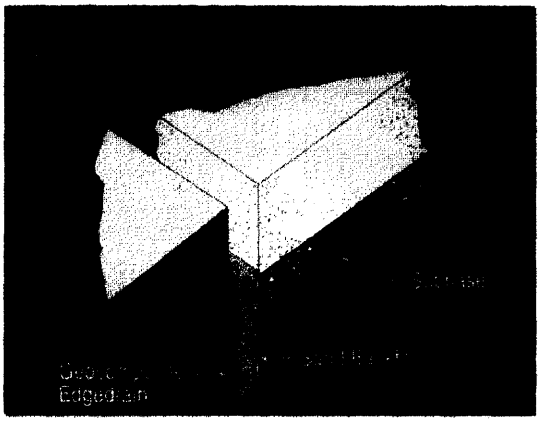
- Structural Core
- Geotextile

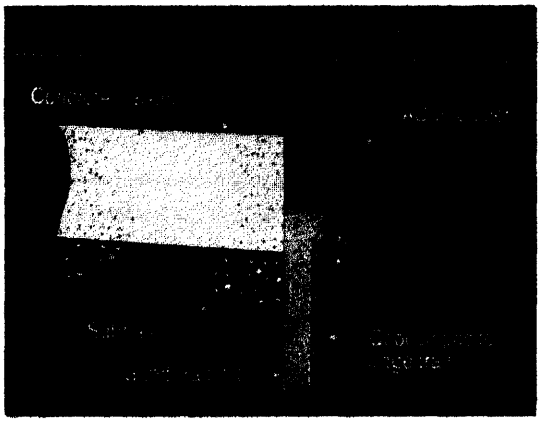
CORE FUNCTIONS

- Structural Strength
- Water Conduit
- Skeleton for Geotextile

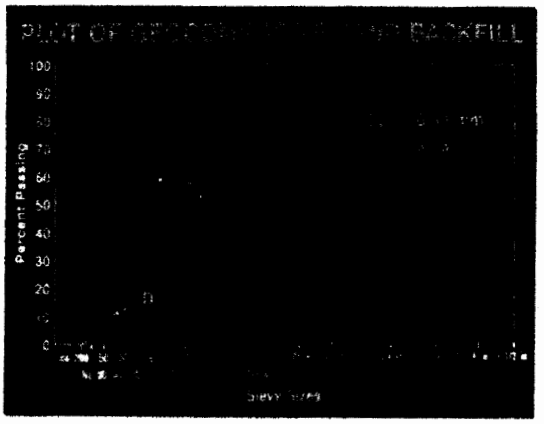
GEOTEXTILE FUNCTIONS

- Transmit Water
- Retain Soil Particles





GEOCOMPOSITE SAND BACKFILL	
Sieve Size	**Percent Passing**
3/8"	100
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	10 – 30
No. 100	2 – 10
No. 200	0 – 2



GEOCOMPOSITE INSTALLATION

Installation of Geocomposite Pavement Drains

ASTM D 6088

SUMMARY

- Edgedrain Pipes Must Be Strong Enough to Resist Wheel Loads
- Dual Outlets Should Be Provided
- Design & Construction Must Consider Maintenance
- Edgedrain System Must Be Intact at the End of the Construction Phase

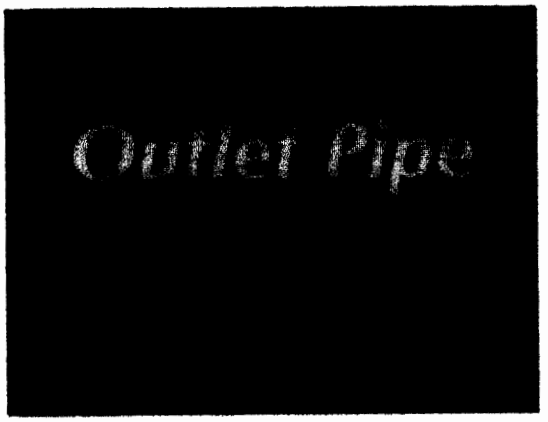
CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

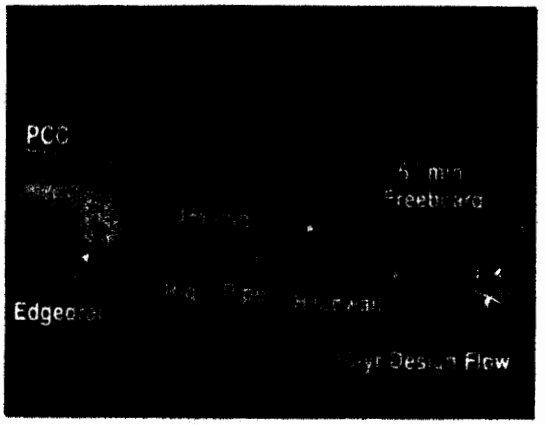
SESSION G

Outlet Pipe
Headwalls
Roadside Maintenance

SESSION OBJECTIVES

- Explain the Need for Adequate Strength Pipe
- Explain the Importance of Providing Dual Outlets
- Discuss Importance of Coordinating Surface & Subsurface Drainage
- Describe Functions of Headwalls
- Explain the Need for Roadside Maintenance





RIGID PIPE

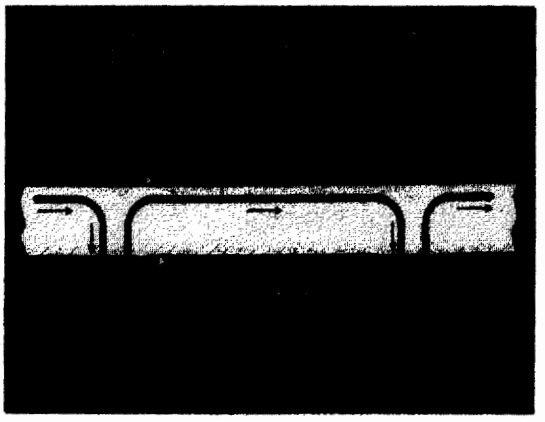
- ASTM D 3034-89
- PVC Sewer Pipe
- SDR 23.5

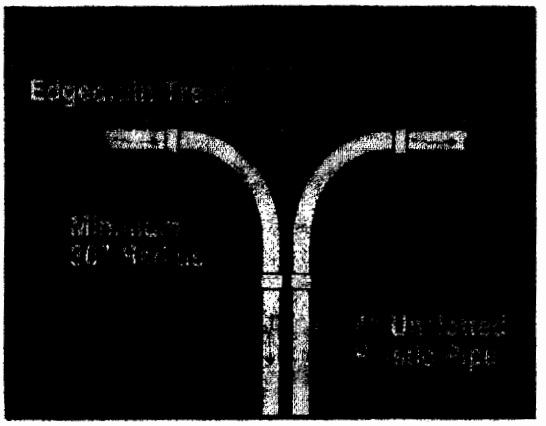
Pipe Slopes Toward Pavement

Low Outlet Pipe

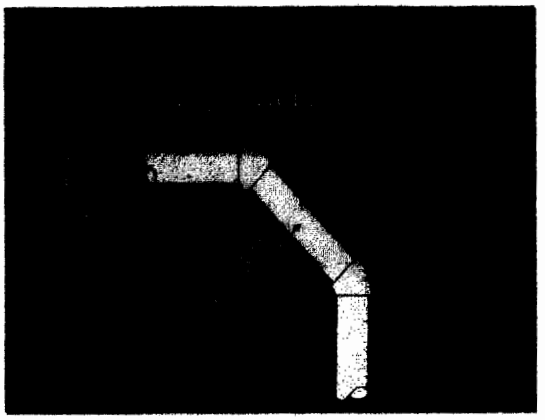
SURFACE WATER COORDINATION

Subsurface and surface water must be coordinated

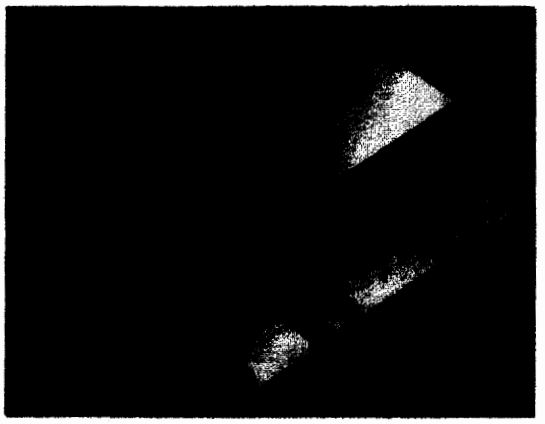


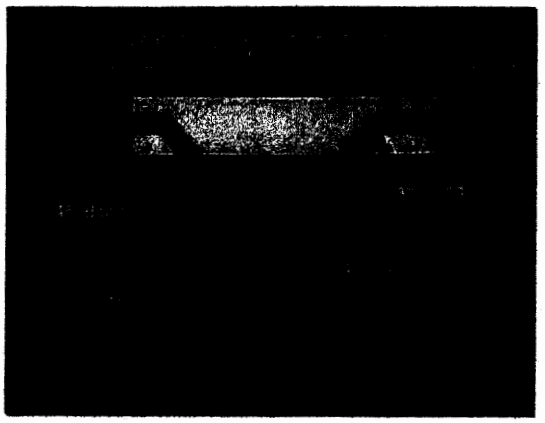


Dual Outlet Pipe



Dual Headwalls





OUTLET SPACING

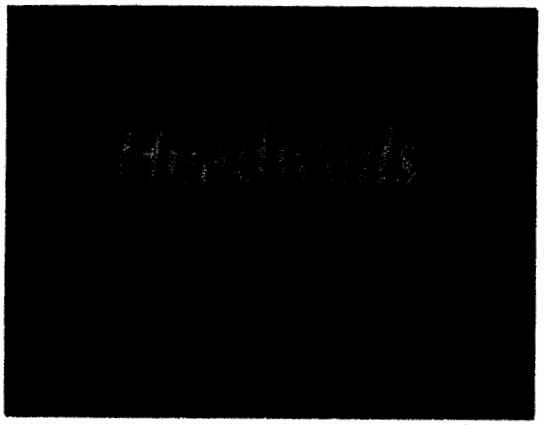
- Segmented Sections
- Limited to 250 feet

Guard Rail Post Driven Through Edgedrain Pipe

Guard Rail Post Driven Through Edgedrain Pipe

VIDEOTAPING

Videotape completed project for quality assurance



PURPOSES OF HEADWALLS

- Pipe Protection
- Erosion Control
- Outlet Location

Crushed Outlet Pipe

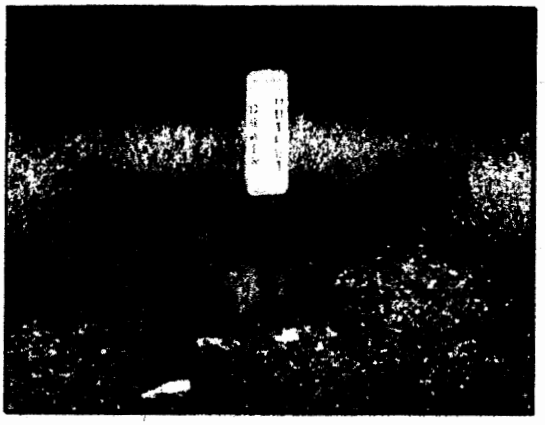
Outlet Erosion

Extreme Outlet Erosion

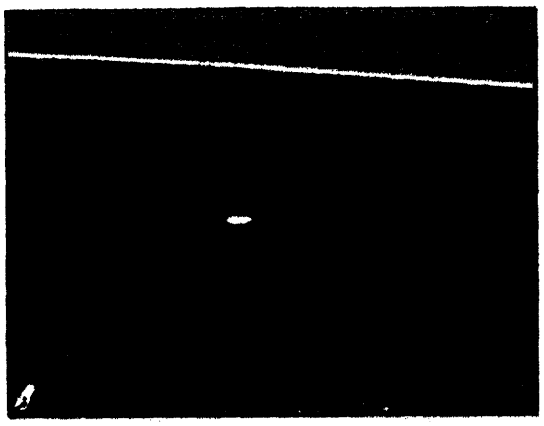
Same Site

REFERENCE MARKERS

FHWA recommends the use of reference markers



Metal Post



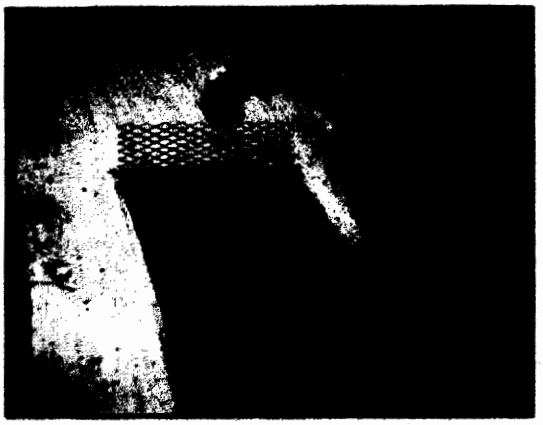
Delineator Disk on the Shoulder

Blue Reflector on R/W Fence

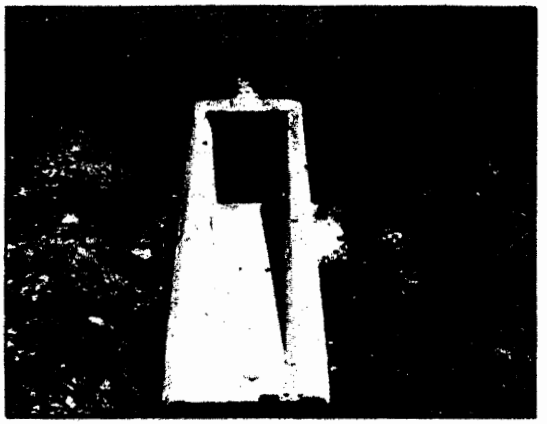
RODENT SCREENS

FHWA recommends the use of rodent screens

Sediment Build up on Inside of Screen



Removable Rodent Screen



Precast Concrete Headwall

Painted Arrow on Shoulder

Large Headwall

Fabric Bag Headwall

Bag Filled

Roadside Maintenance

Freely Discharging Outlet

Clogged Headwall

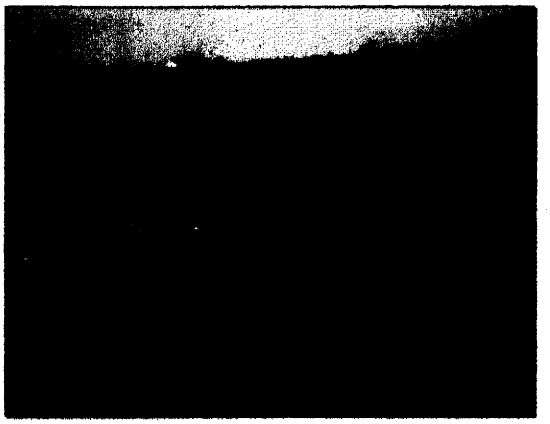
Reconstructed Shoulder – Signs of Pumping

Vegetative Mat

Crushed & Clogged Outlet Pipe

Hidden Outlet Pipe

Opened Outlet Pipe

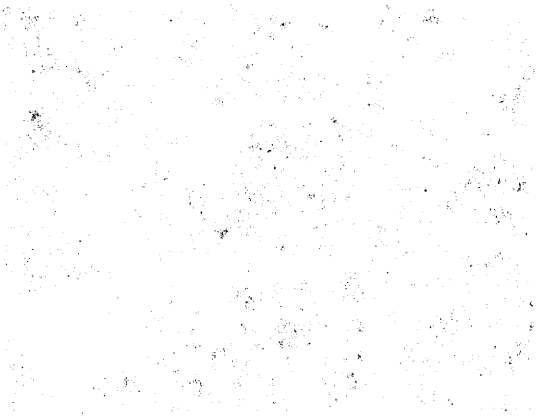


Clogged Roadside Ditch

Crushed Edgedrain Pipe

SUMMARY

- Provide Strong Outlet Pipes
- Coordinate Surface & Subsurface Drainage
- Provide Dual Outlets
- Provide Headwalls
- Provide Roadside Maintenance



CONSTRUCTION of PAVEMENT SUBSURFACE DRAINAGE SYSTEMS WORKSHOP

SESSION H

Video Inspection
Maintenance

SESSION OBJECTIVES

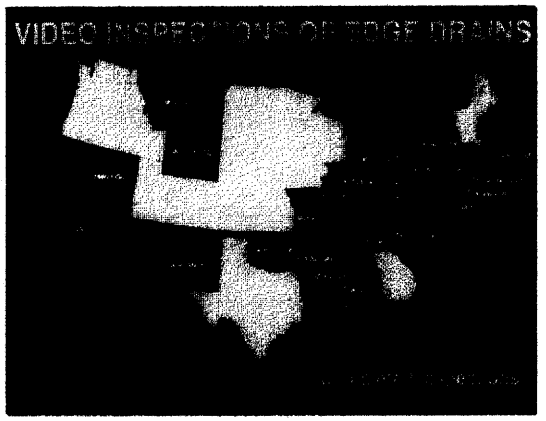
- **Identify Role of Video Inspection for Quality Assurance**
- **Explain Need for Routine Video Inspections**
- **Discuss Maintenance's Effect on Pavement Performance**
- **Express Need for Maintenance Commitment**

PURPOSE

- Qualitative Picture of Edgedrain Conditions
- Demonstrate Video Equipment

BENEFITS

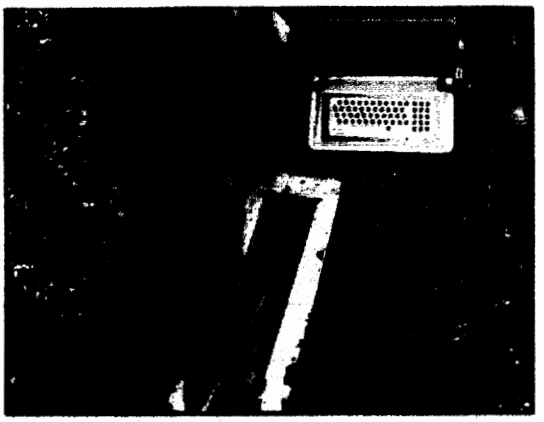
- Quality Control
- Maintenance



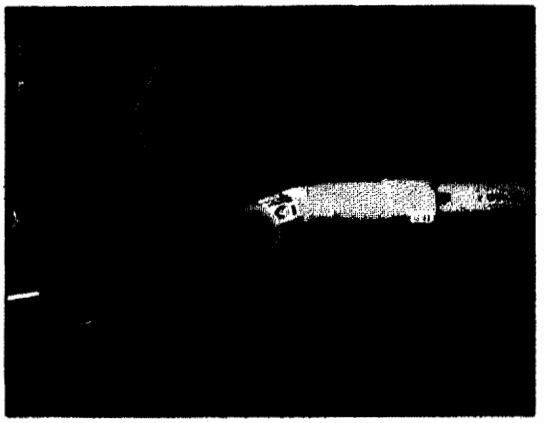
Inspection Party

Camera Head

Entering Data



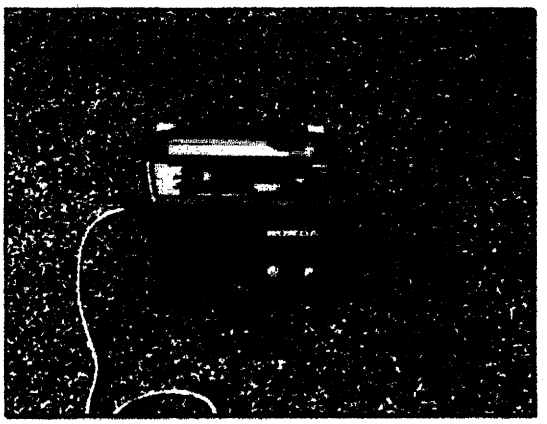
Camera Inserted



Pipe Sleeve

Inserting Sleeve

Ready to Start Inspection



Portable Generator

PVC Pipe – Joints Opened

Crushed Pipe

Brick as a Stopper

6"x 6" 90 Degree Tee

Camera Rotates

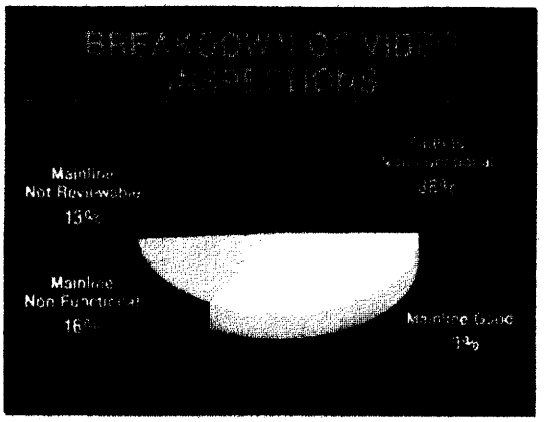
Crushed Pipe

Rodent's Nest

Sediment Build-up

Mouse

Everybody Wants to Be Jerry Seinfeld



IMPROVEMENT NEEDED

- **2/3 of Edgedrains Not Functioning Properly**
- **Must Make a Significant Improvement**

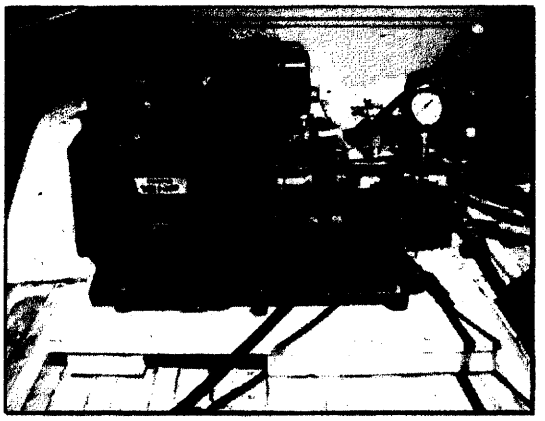
  or

- **Abandon Drainage**

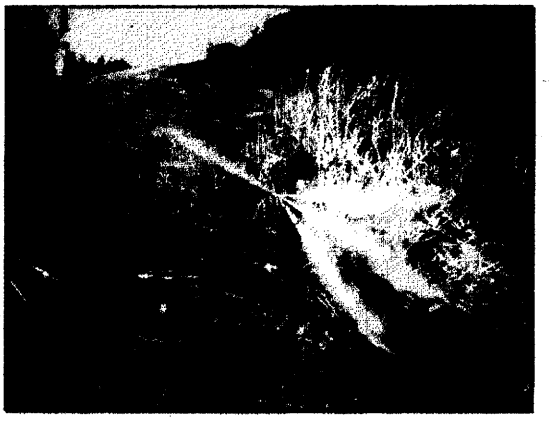
Maintenance

MAINTENANCE

- **Periodical flush edgedrain system to remove sediment buildup**



Jeter Pump



Jeter Pump Head

Cleaning Pipe

MAINTENANCE

- **Mow around outlet pipes at least twice yearly**
- **Mow and clean roadside ditches**

MAINTENANCE

- **Inspect outlet pipes and pipe systems at least once per year**
- **Use video inspection equipment to inspect edgedrain systems**

Maintenance is Critical to the Continued Performance

MAINTENANCE

- No Maintenance Commitment
- No Drainable Systems

SUMMARY

- Video Inspection Acceptance
- SHA's Should Have Routine Program of Video Inspection
- Maintenance is Critical to Continued Performance of Drainage Systems
- No Maintenance Commitment – No Drainable Systems

COURSE SUMMARY

- **Provided Design/Construction Guidance for Pavement Subsurface Drainage Systems**
- **Emphasized on Video Inspection of Edgedrains for Quality Assurance**
- **Emphasized on the Need for Maintenance**

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