CE 451: Transp. Engg. II- Pavement Design and Railway Engineering

LOW COST ROAD; EQUIPMENTS; CONSTRUCTION OF EMBANKMENT, SUBGRADE, BASE, FLEXIBLE AND RIGID SURFACE; AND MAINTENANCE OF FLEXIBLE AND RIGID ROAD PAVEMENTS

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CONSTRUCTION OF CONCRETE PAVEMENTS

STEPS:

1. Preparation and preliminary finishing of subgrade
2. Placing of forms
3. Final finishing of the subgrade
4. Installation of joints
5. Batching of aggregate and cements
6. Mixing and placing concrete
7. Placing and finishing concrete
8. Slipform paving
9. Curing

FIGURE 20-12 Cutting of trench to exact line and grade, prior to placing of forms. (Courtesy Portland Cement Association.)

FIGURE 20-14 Tilting drum mixer discharging concrete into agitating body truck. (Courtesy Wire Reinforcement Institute.)

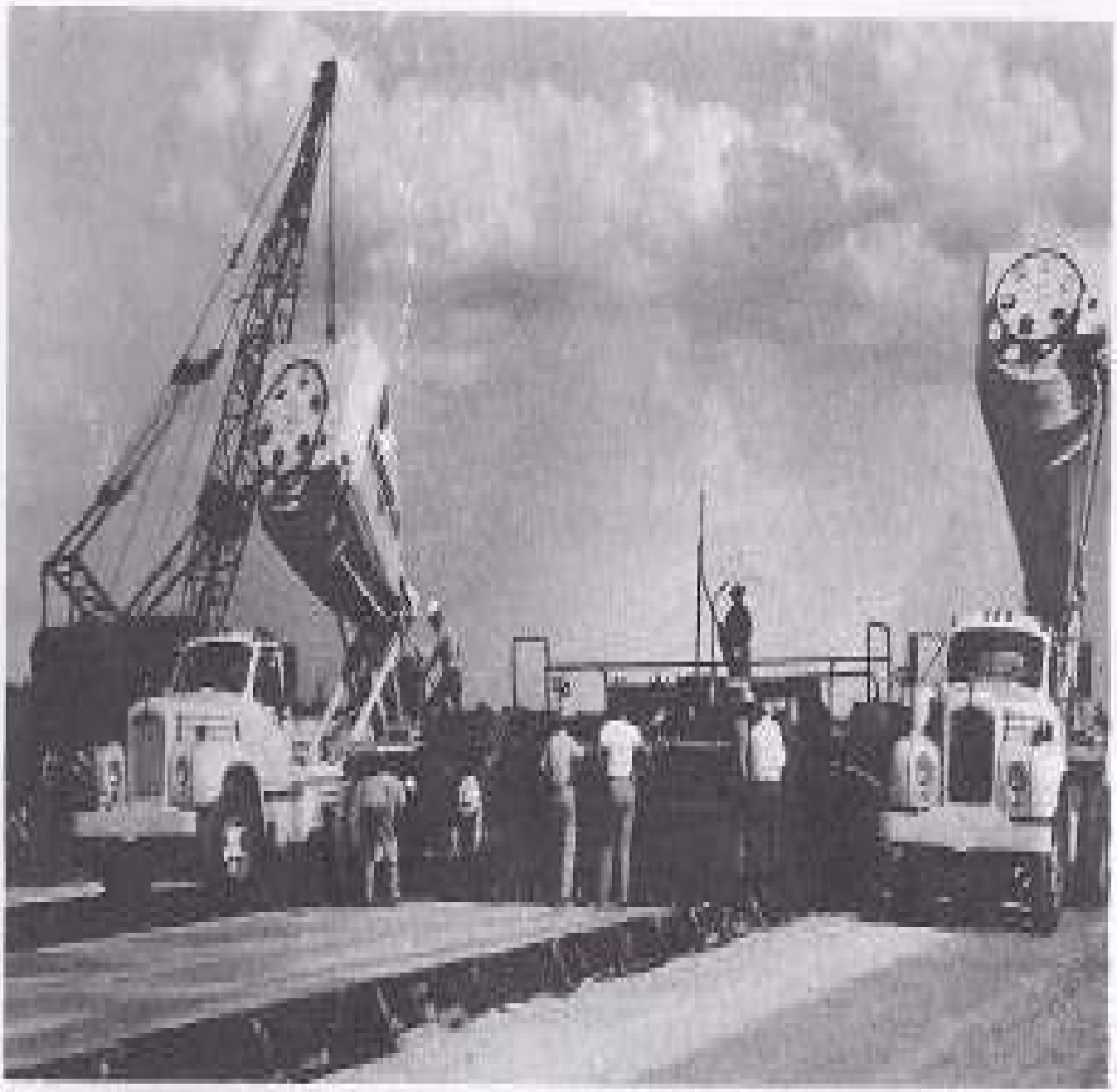


FIGURE 20-15 Agitating-body trucks discharging concrete into hopper-type spreader. (Courtesy *Engineering News-Record.*)

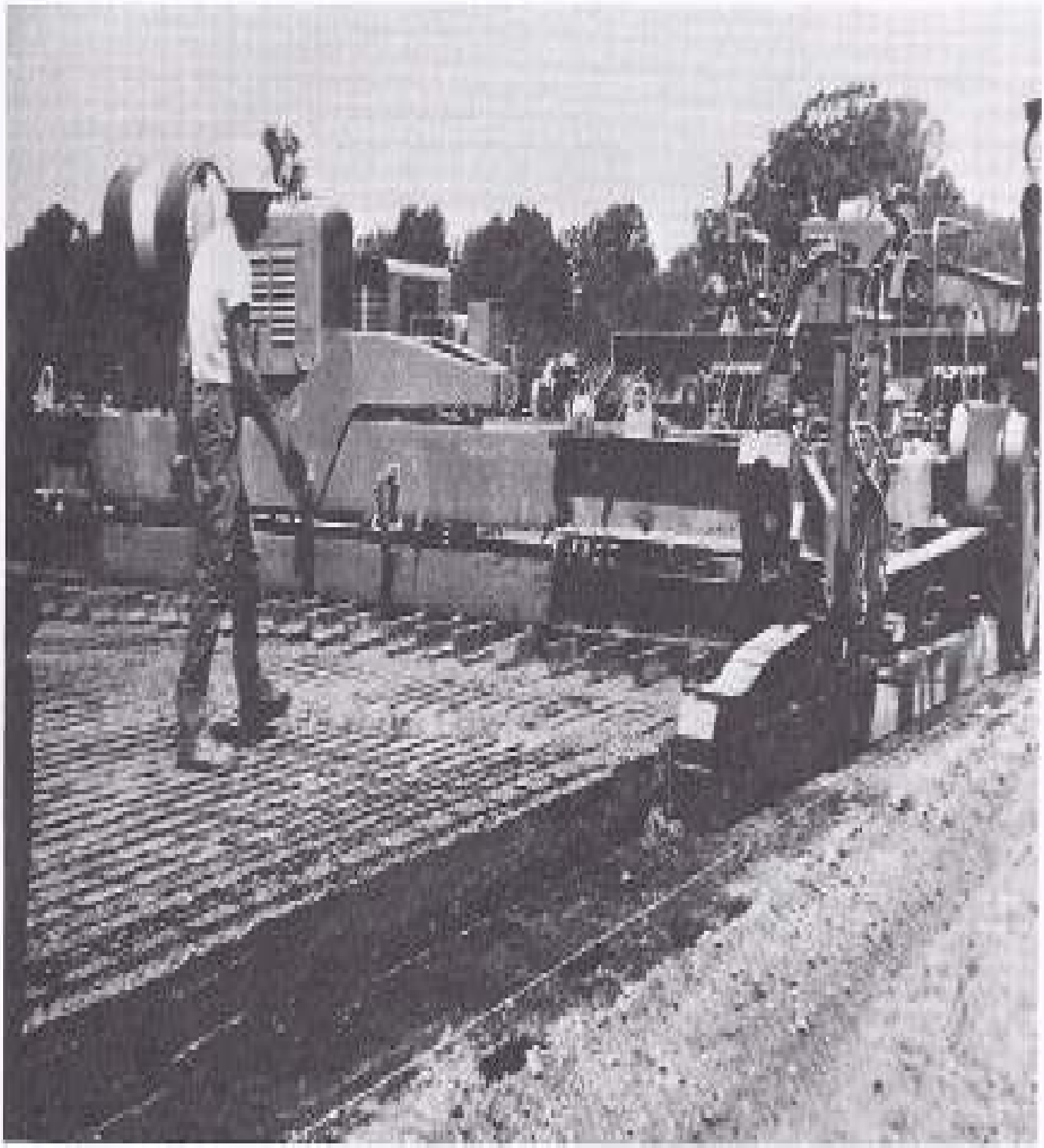


FIGURE 20-16 Blades of mesh placer push and vibrate reinforcing steel into fresh concrete. (Courtesy Portland Cement Association.)

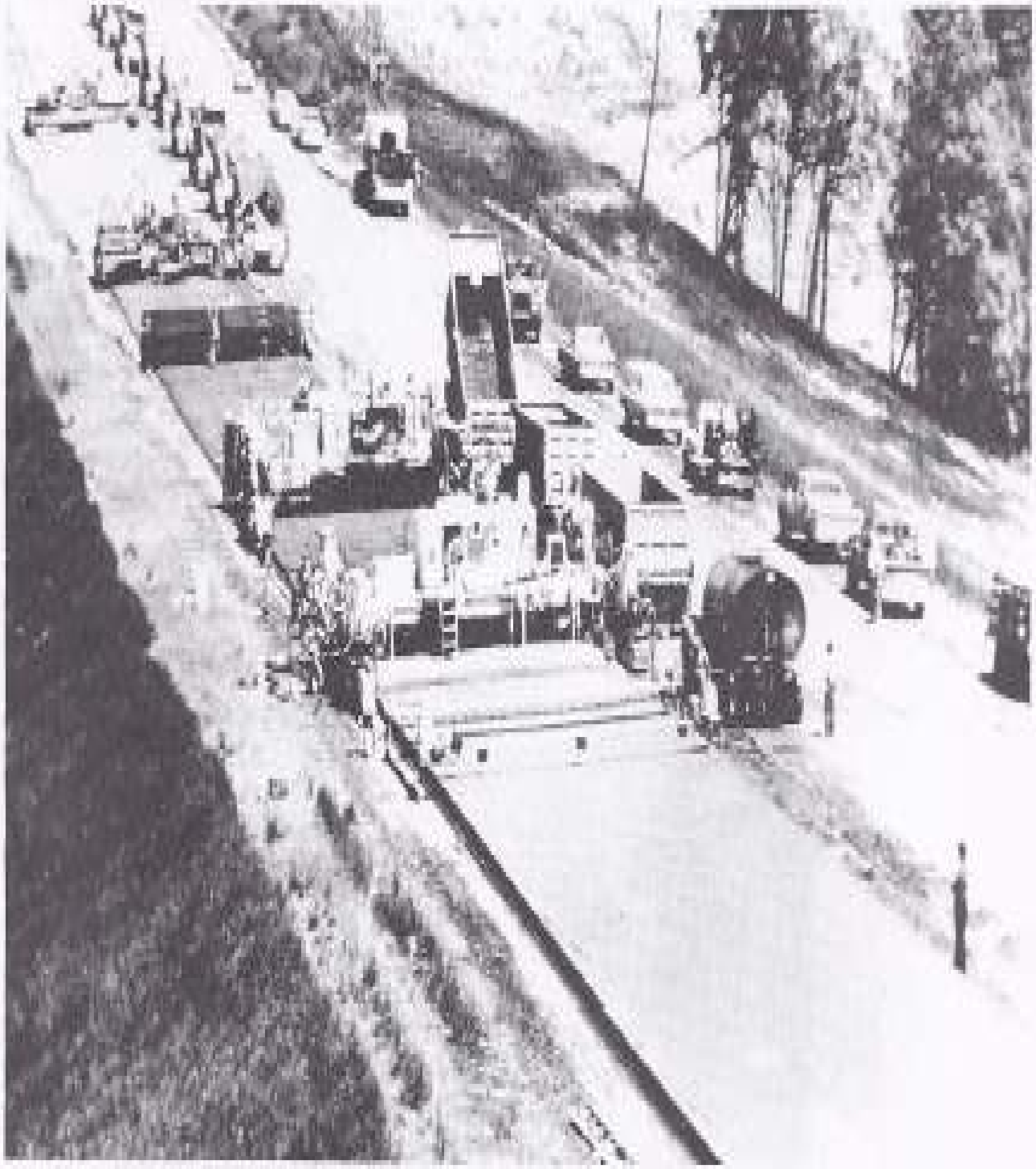


FIGURE 20-17 Slipform paver at work on an interstate project. (Courtesy Portland Cement Association.)

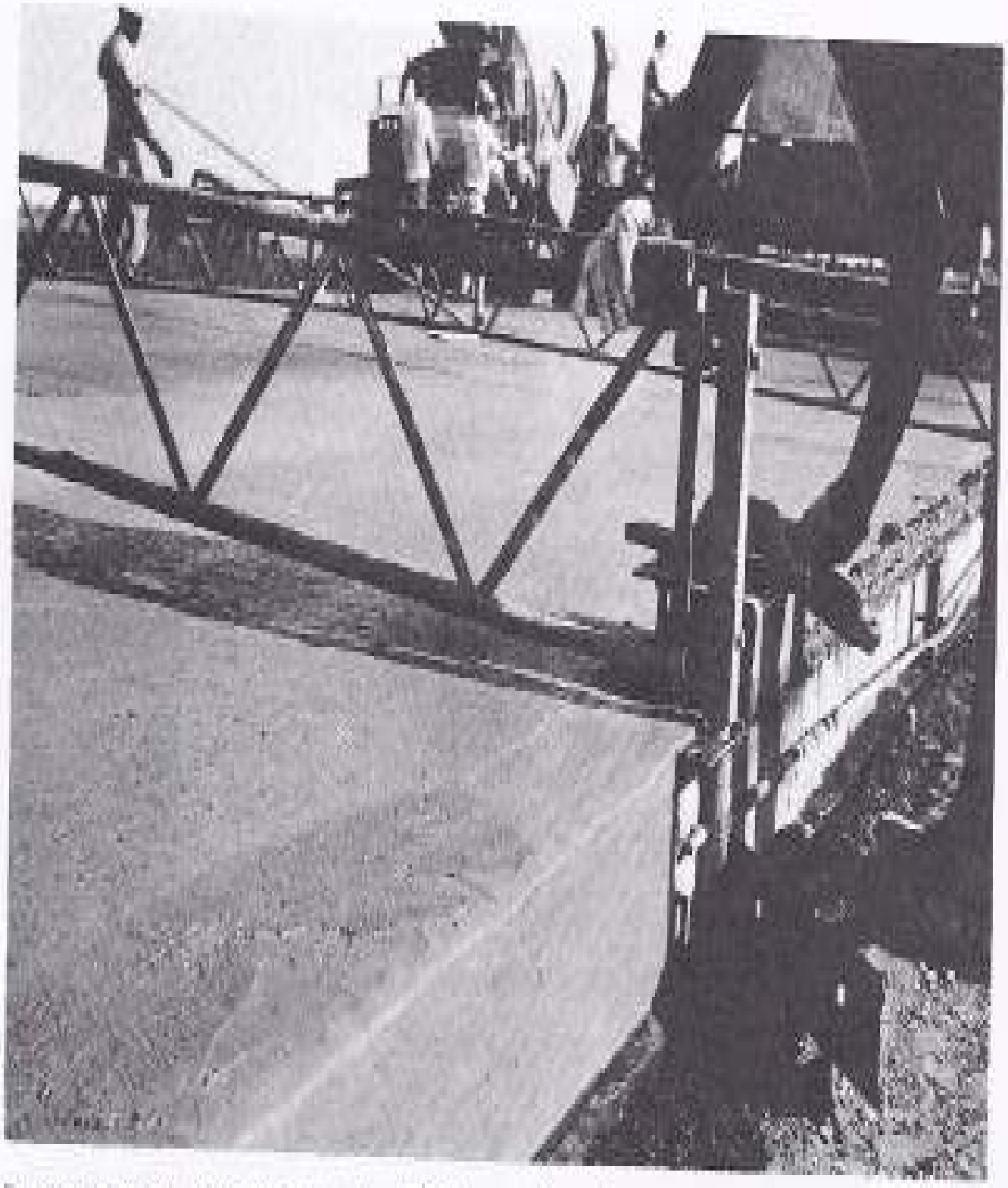
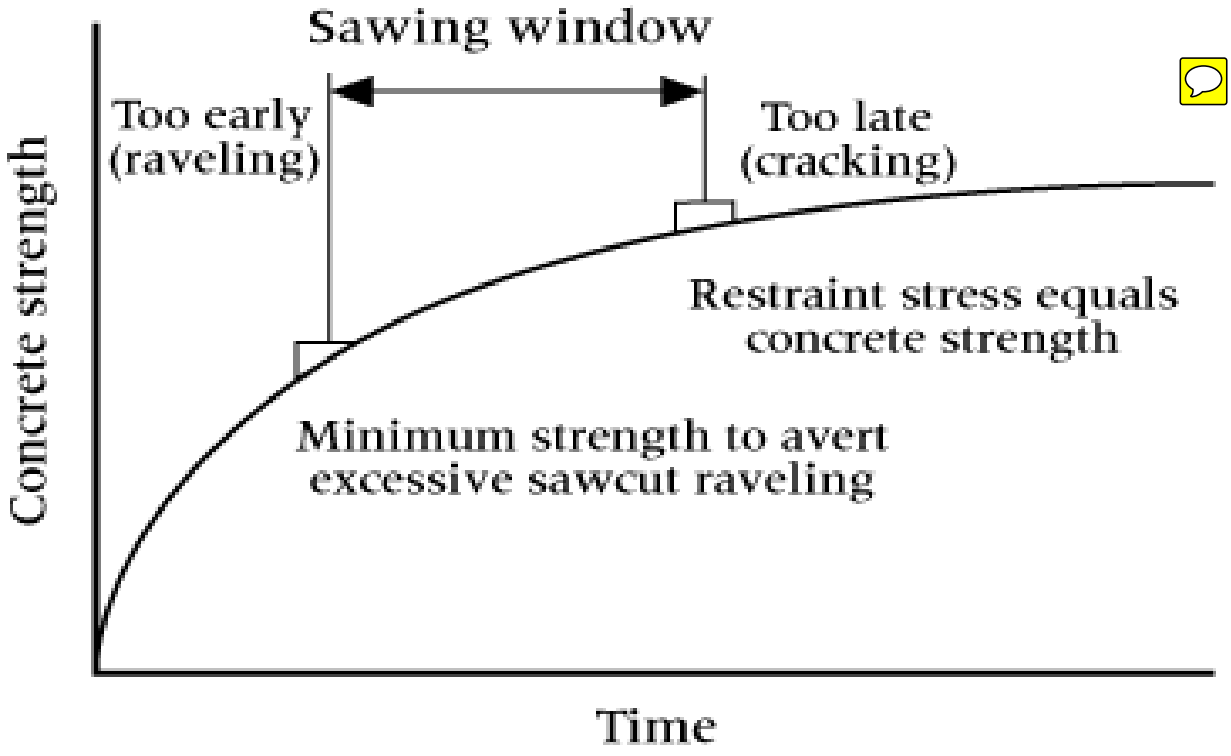


FIGURE 20-18 Pavement edge left by trailing form of slipform paver. (Courtesy Wire Reinforcement Institute.)

FIGURE 20-20 Concrete saw with a diamond blade cutting a pavement joint. (Courtesy Portland Cement Association.)


Sawing window
Too early
(raveling)
Too late
(cracking)
Restraint stress equals
concrete strength
Minimum strength to avert
excessive sawcut raveling
Concrete strength
Time

CONSTRUCTION JOINTS

TRANS & LONG. JTS

RIGID STEEL PLACED

SLAB FINISHING

PAVING TRAIN

Equipment Required:

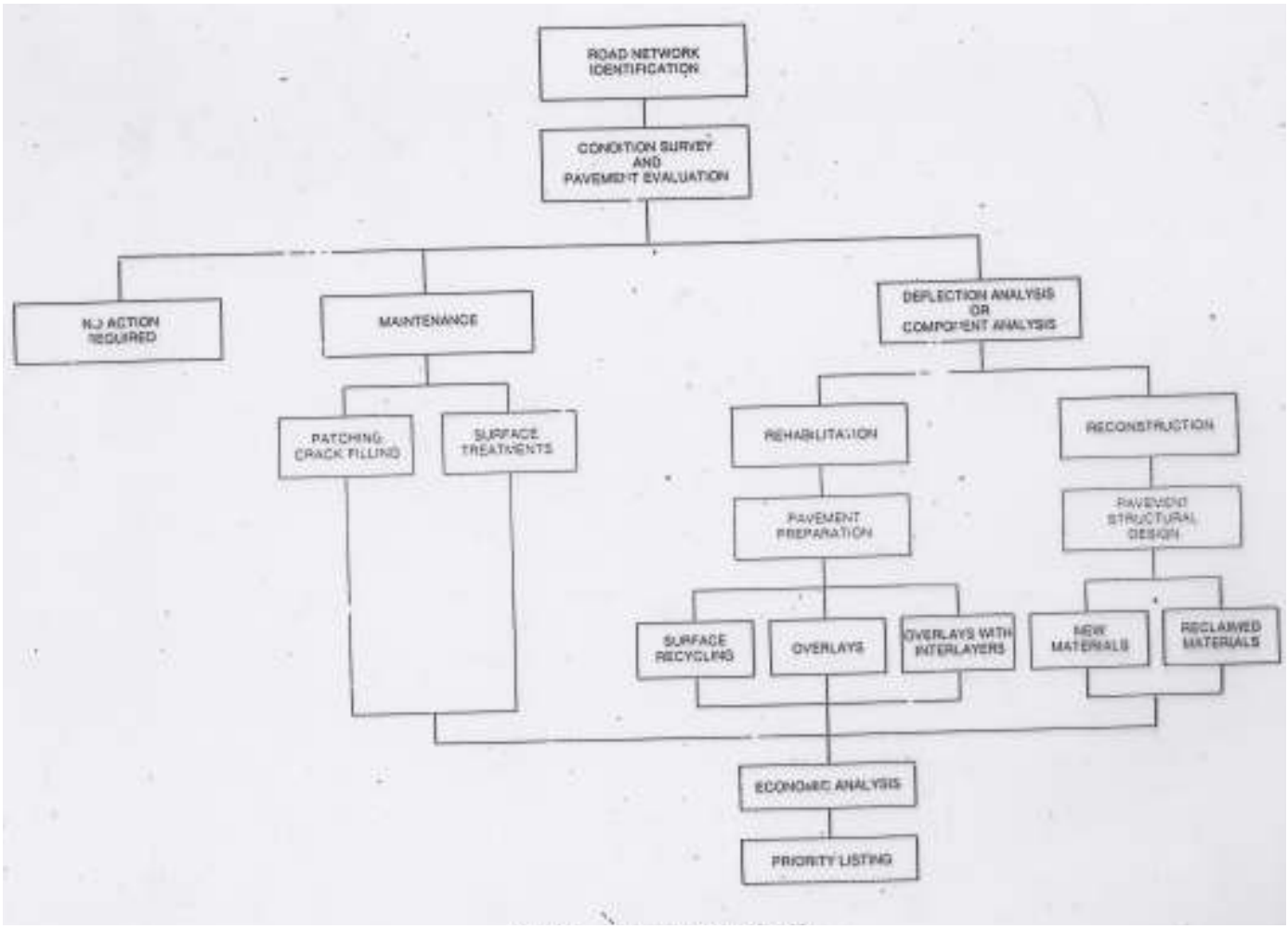
- ❖Motor grader
- ❖Slip form paver, steel forms, special forms for curbs, gutter
- ❖Form grader to cut trench for form placing .
- ❖“Sub grader” or “Fine grader”.
- ❖Joint installer.
- ❖Concrete mixing plant and agitating body truck.
- ❖Automatic plant with moisture sensing device , slump meter
- ❖Spreader with vibrator

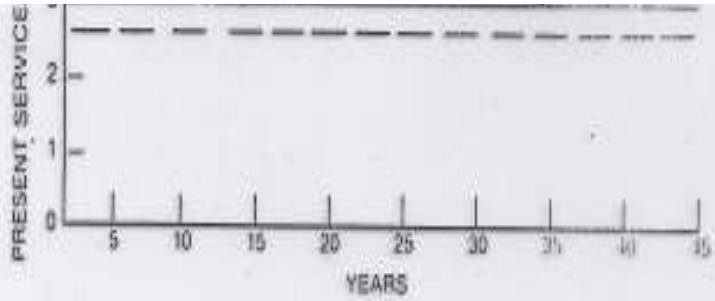
Placing of distributed in two ways:

- ➢half depth of concrete than wire mesh placed ,than another half depth of concreting
- ➢full depth of concreting long steel on top and using mesh installer steel in forced to required depth .

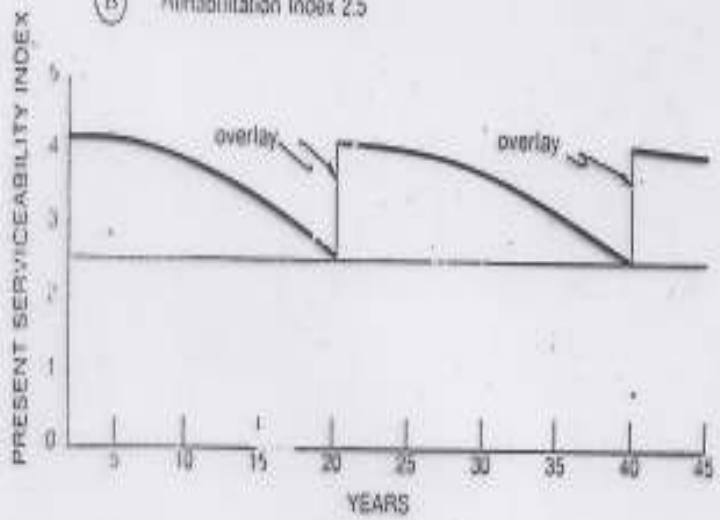
Curing:

1. Earth/Straw in wet condition .
2. Burlap, cotton mat
3. Water proof paper
4. Light colored fluid membrane
5. Forms removed after 12-24 hrs
6. Final furnish to edge.

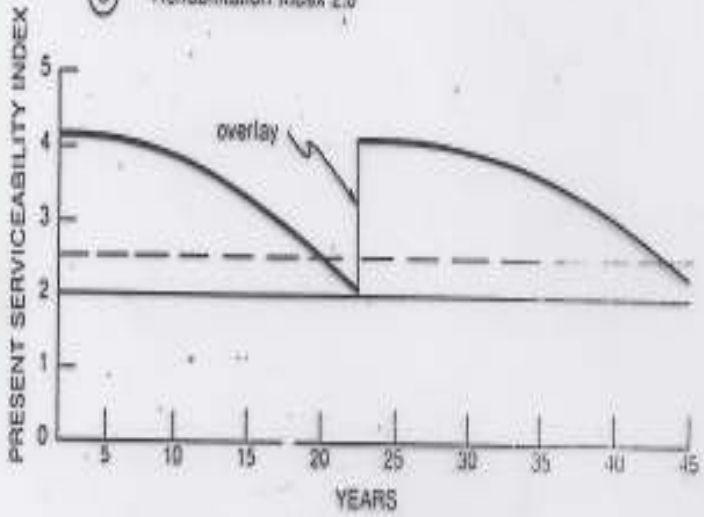

ROAD NETWORK IDENTIFICATION
CONDITION SURVEY AND PAVEMENT EVALUATION
NO ACTION REQUIRED
MAINTENANCE
DEFLECTION ANALYSIS OR COMPONENT ANALYSIS
PATCHING CRACK FILLING
SURFACE TREATMENTS
REHABILITATION
RECONSTRUCTION
PAVEMENT PREPARATION
PAVEMENT STRUCTURAL DESIGN
SURFACE RECYCLING
OVERLAYS
OVERLAYS WITH INTERLAYERS
NEW MATERIALS
RECLAIMED MATERIALS
ECONOMIC ANALYSIS
PRIORITY LISTING



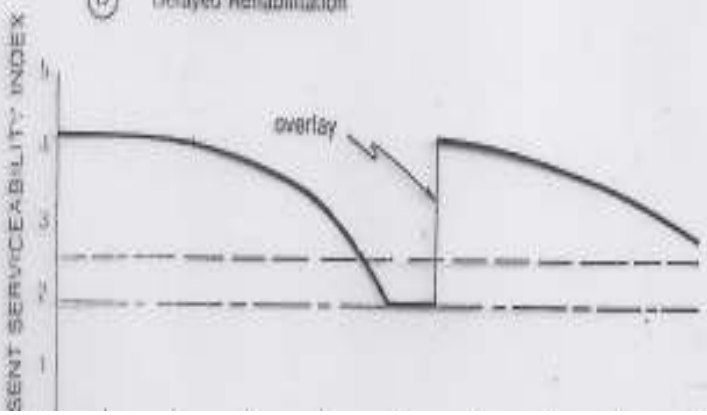
(B) Rehabilitation Index 2.5



(C) Rehabilitation Index 2.0



(D) Delayed Rehabilitation



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High way maintenance & rehabilitation:

High way maintenance is defined as the function of preserving, repairing and restoring a highway and keeping it in condition for safe, convenient and economical use ,types of roadway maintenance and construction activities .

Maintenance: traffic service & physical maintenance .

Construction: betterment ,construction and reconstruction .

Maintenance management system :

- ❑development of an annual work program
- ❑budgeting and allocating resources.
- ❑Work authorization and control.
- ❑Scheduling
- ❑Performance evaluation
- ❑Fiscal control

Maintenance of bituminous surfaces:

- ➢Patching
- ➢Paint patching
- ➢Scarifying
- ➢Resealing → by seal coat
- ➢Non skid surface treatments →slurry seal coat with sharp, angular aggregate.
- ➢Patching: thin coat of bitumen + coarse mineral aggregate
- ➢Paint patching: To seal and strengthen WC bitumen + fine material & then boomed to clean up
- ➢Scarifying: if large area in poor shape, than it scarified and reworked.

TABLE 1 SOME ALTERNATIVES IN PAVEMENT MAINTENANCE, REHABILITATION, AND RECONSTRUCTION

PROBLEM	POSSIBLE CAUSE				MAINTENANCE[1]				REHABILITATION[2]				RECONSTRUCTION[3]	
	Structural Failure	Mix Composition	Temp. or Moisture Changes	Const.	Patching & Routine Maintenance	Fog Seal	Surface Treatment	Slurry Seal	Surface Recycling	Thin Overlay	Open-Graded Surface	Structural Overlay	Recycled Materials	New Materials
Alligator Cracking	X						X[4]	X[5]				X	X	X
Edge Joint Cracks	X		X	X	X									
Reflection Cracks					X		X[4]	X[5]			X[6]	X		
Shrinkage Cracking		X	X				X	X	X		X[6]	X		
Slippage Cracks				X	X									
Rutting	X	X		X					X	X[7]		X	X	X
Corrugation	X	X		X					X	X[8]		X	X	X
Depressions	X			X	X								X	X
Upheaval			X		X								X	X
Potholes		X	X	X	X									
Raveling		X		X		X[5]	X		X	X	X			
Flushing Asphalt		X	X	X			X		X		X			
Polished Aggregate		X	X				X		X	X	X			
Loss Of Cover Aggregate		X		X			X							

NOTES: 1. Refer to Asphalt in Pavement Maintenance (MS-16), The Asphalt Institute, for details. 2. When cracking exceeds 40 percent of the surface area of the pavement. 3. If problem is extensive enough. 4. Deep patch-permanent repair. 5. Temporary repair. 6. When accompanied with surface recycling. 7. When rutting is minor. 8. Over planed surface.

CRACKS IN PAVEMENT

ALLIGATOR CRACK

CRACKS IN PAVEMENT

POTHOLE

REFLECTION

CRACKS IN PAVEMENT

RUT

CRACKS IN RIGID

CRACKS IN PAVEMENT

CRACK SEALED

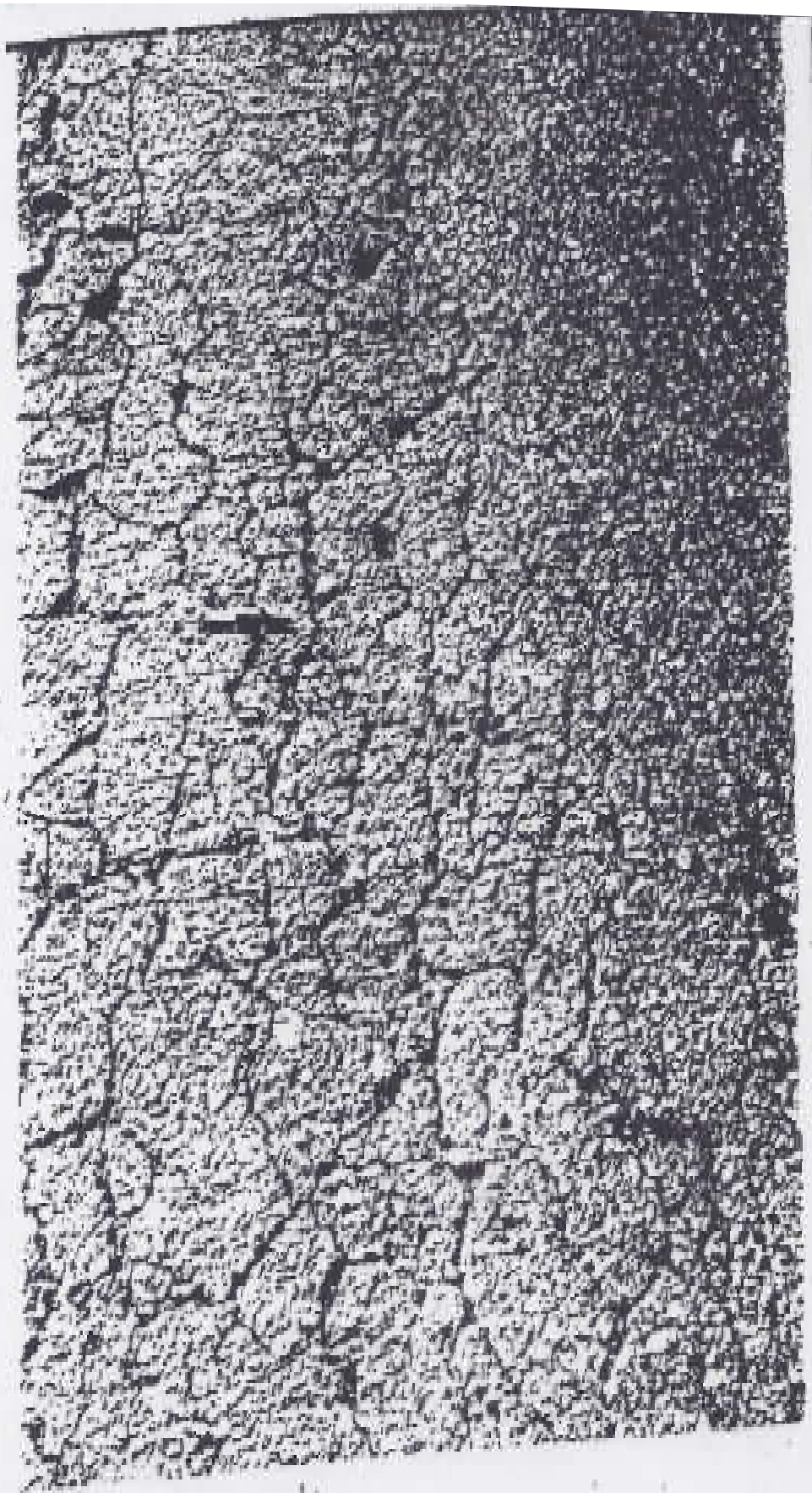
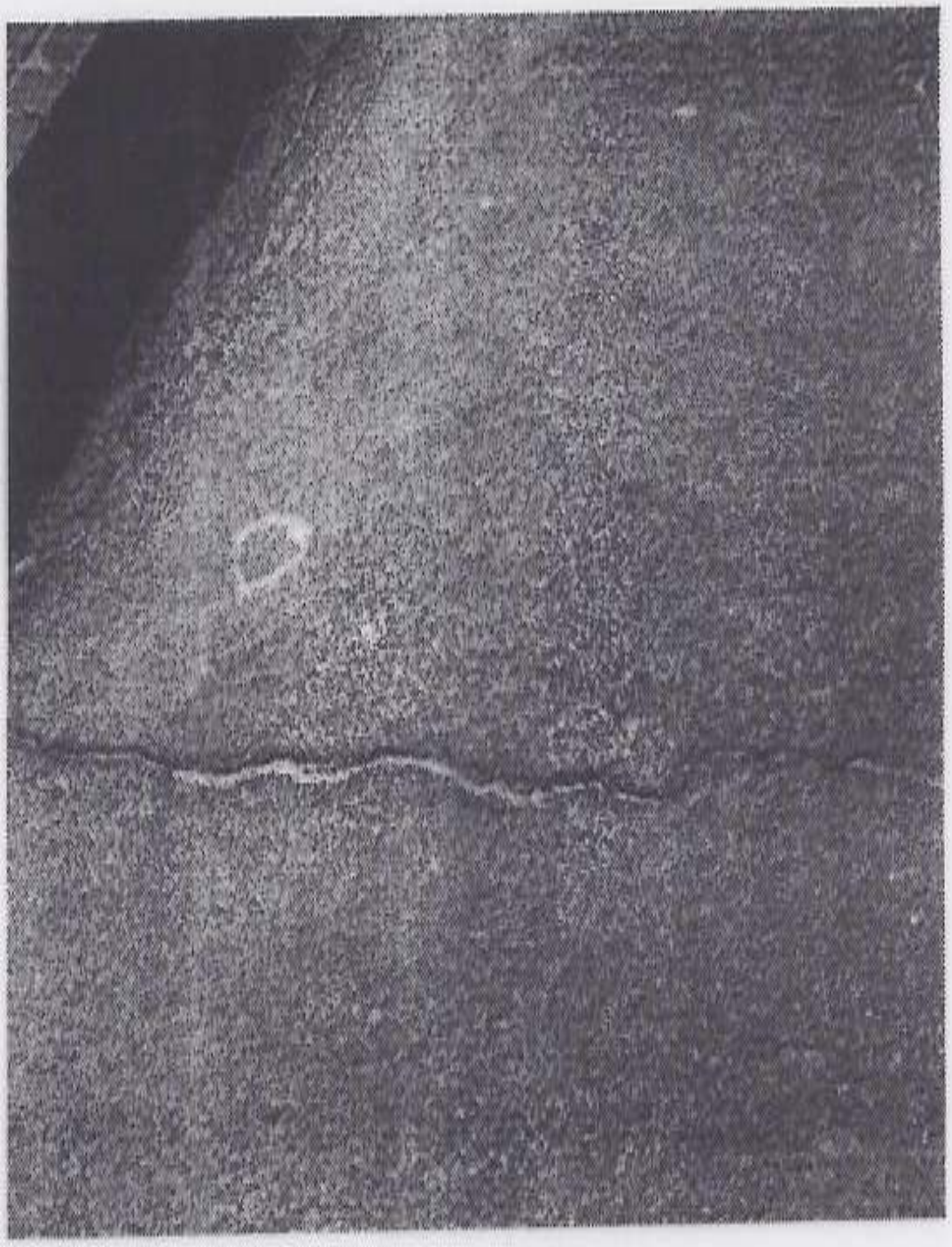
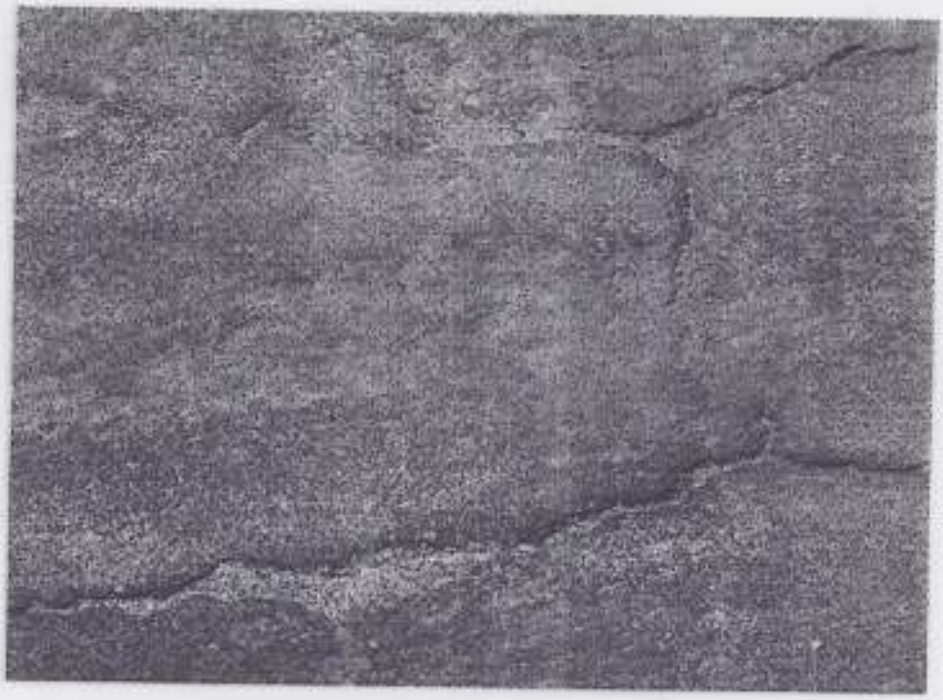


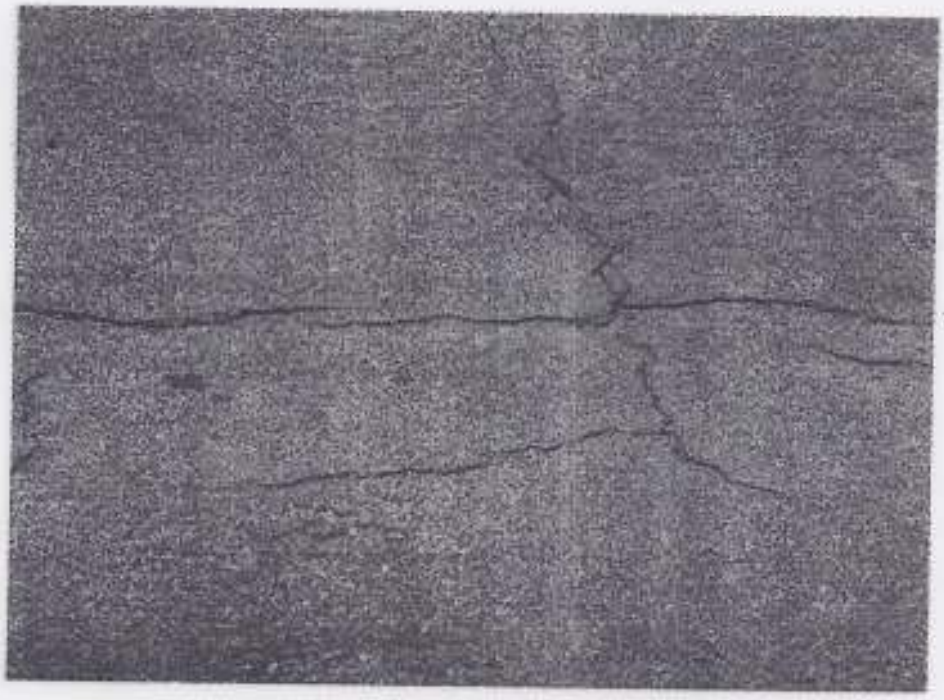
Figure A-2 -Alligator cracks

Type-2. Edge Transverse/Longitudinal Cracks

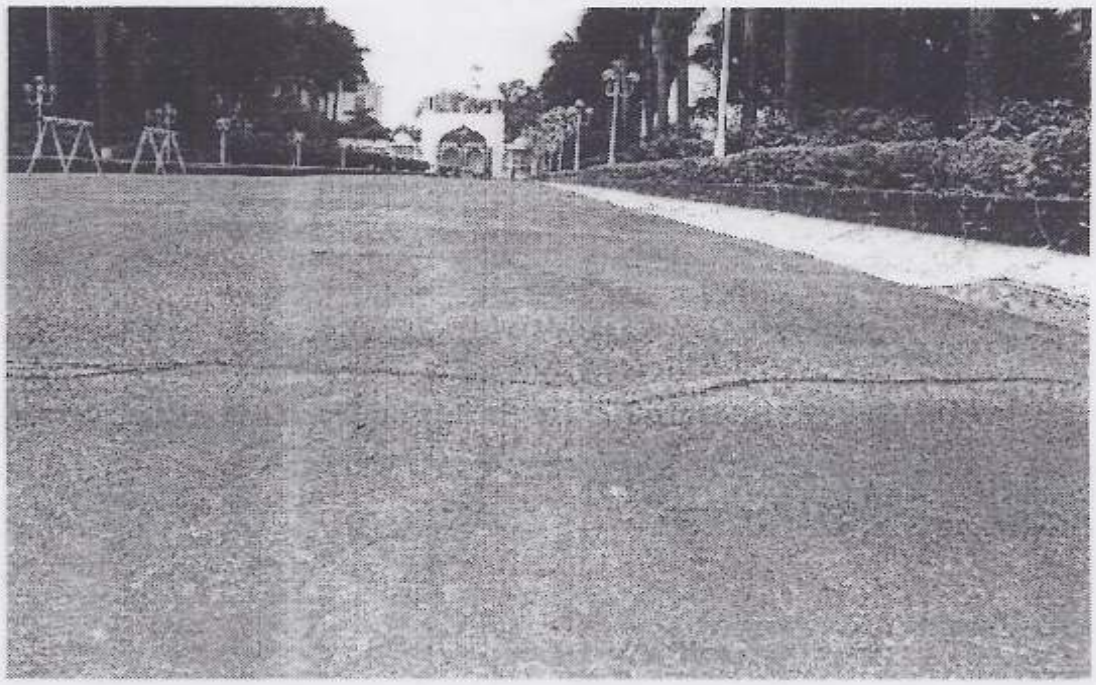


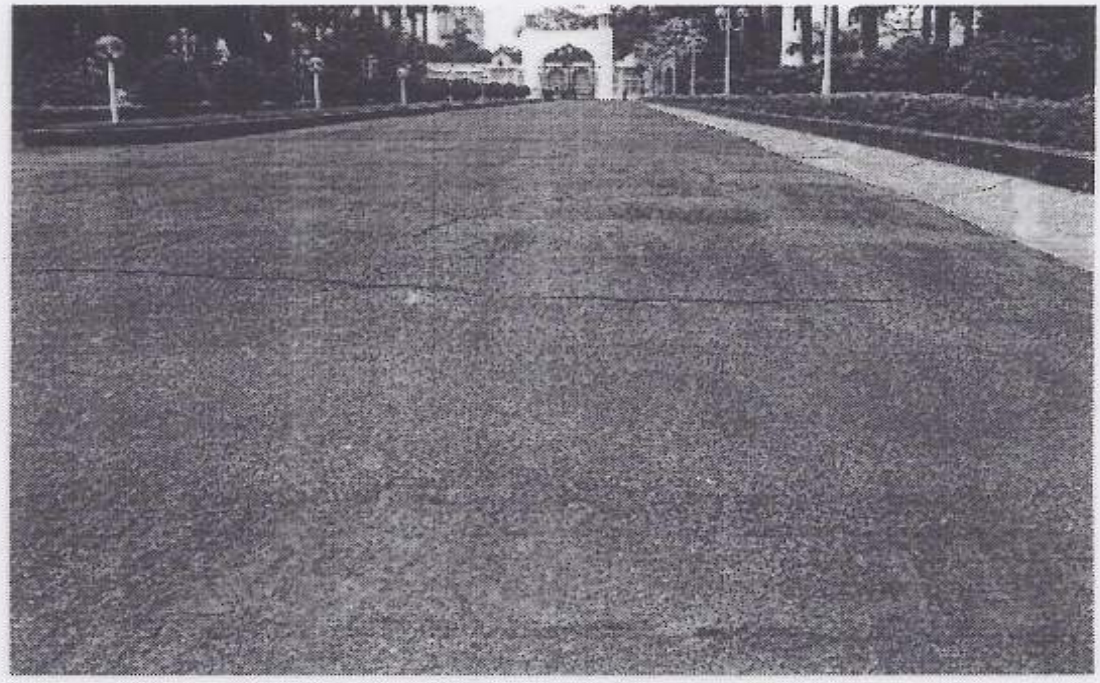
Type-1. Shrinkage Cracks



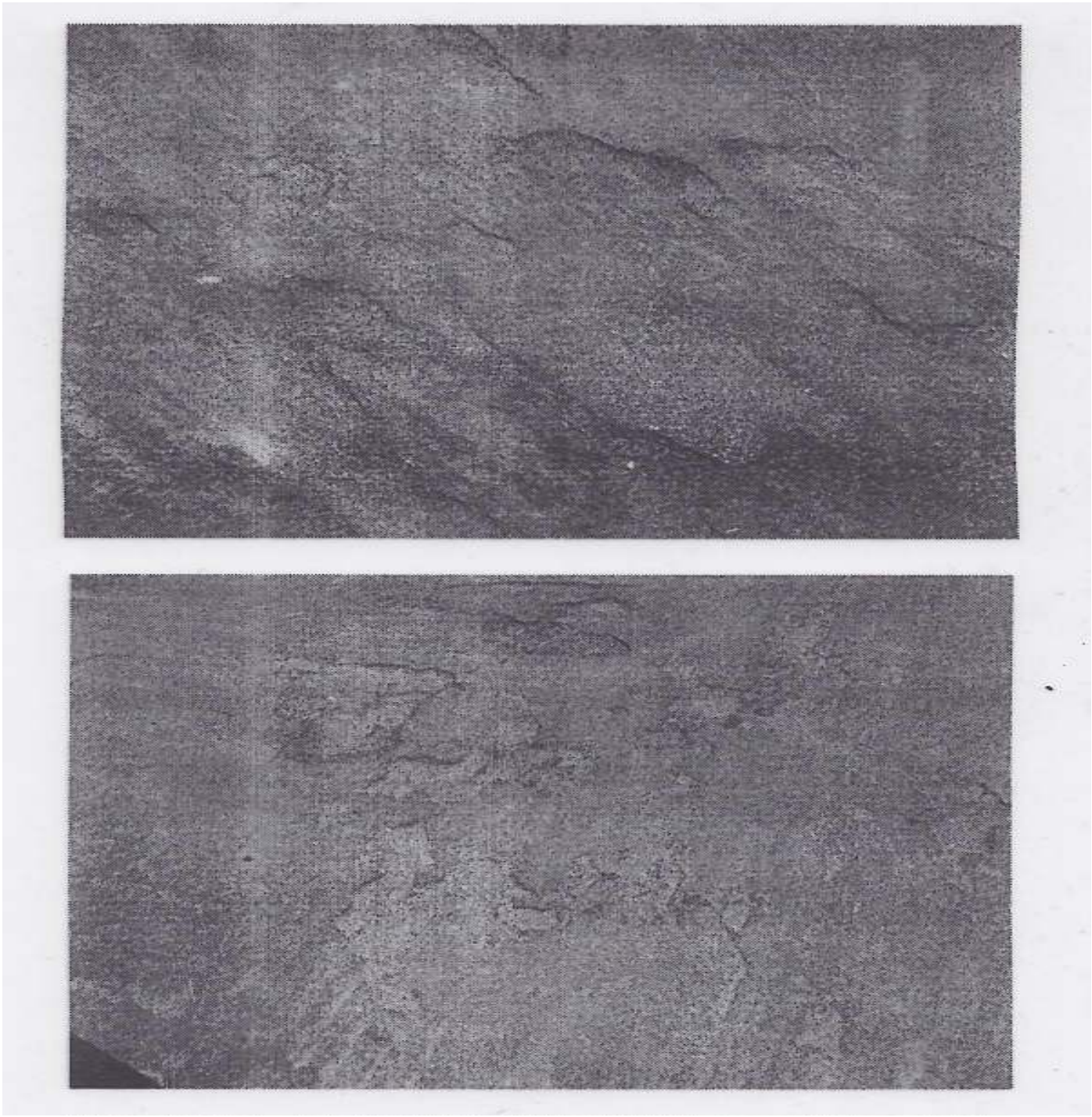


Type-6. Utility Cut Related Cracks





LOSS OF COVER AGGREGATE



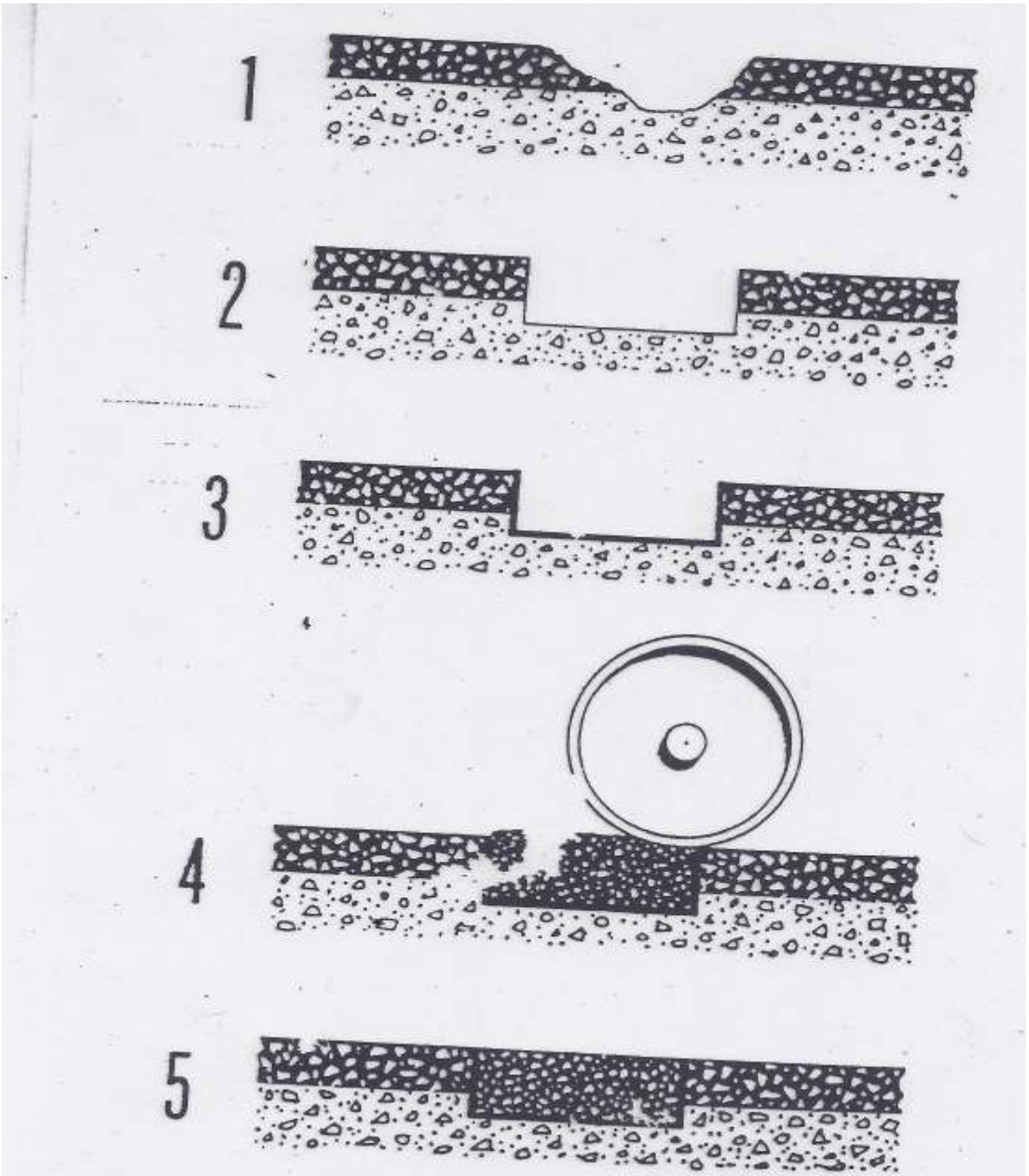
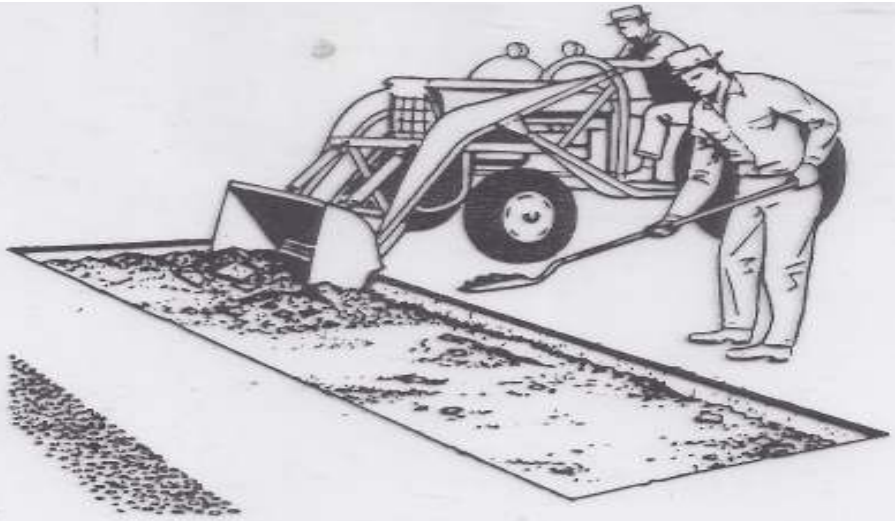
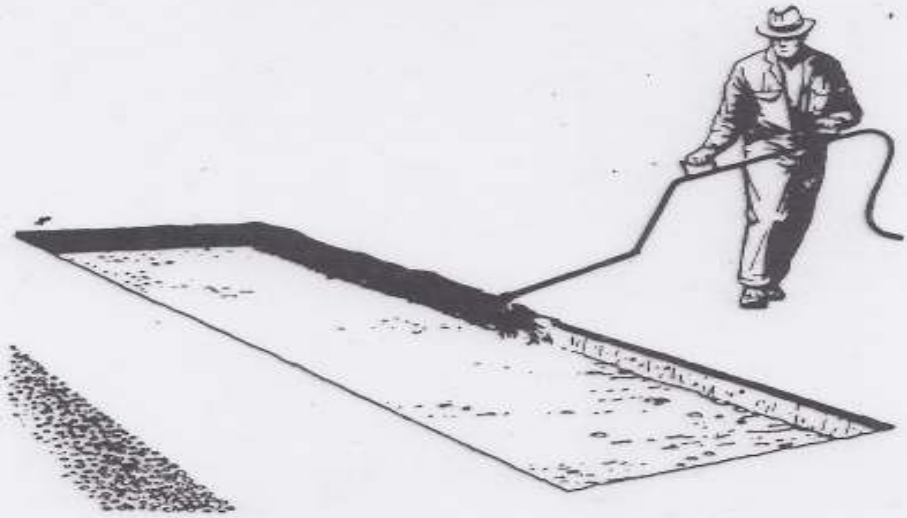


Figure II-60—Pothole permanent repair. (1) Untreated pothole, (2) Surface and base removed to firm support, (3) Tack coat applied, (4) Full-depth asphalt mixture placed and being compacted, (5) Finished patch compacted to level of surrounding pavement.



(a) Removing surface and base

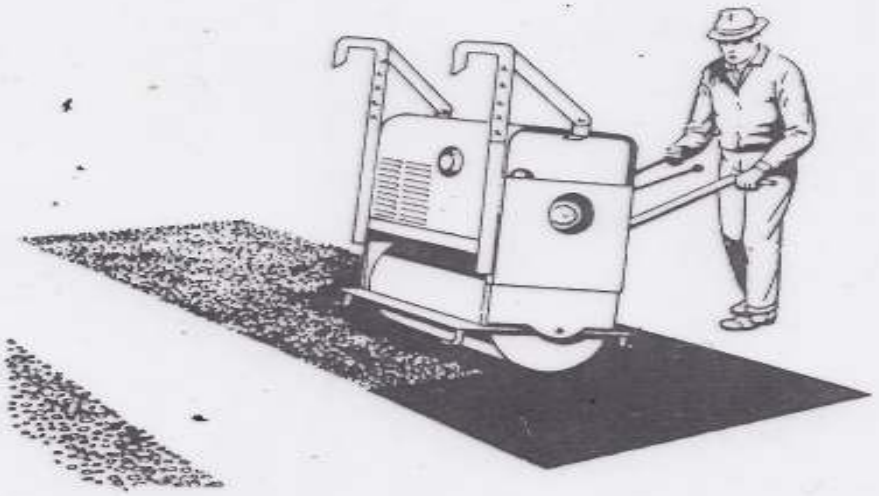


(b) Applying tack coat to vertical surfaces

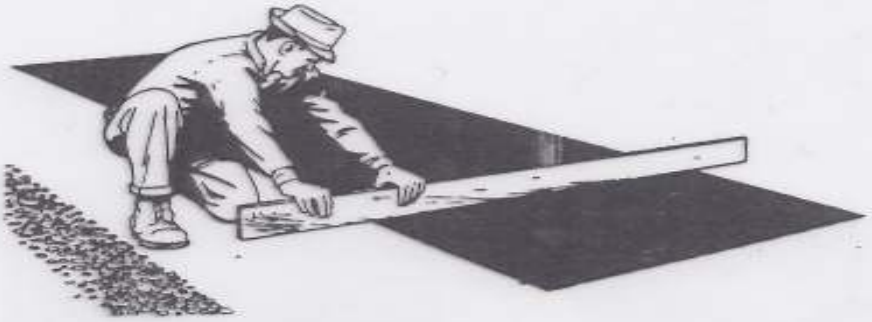
(c) Backfilling hole with plant–mix

FIGURE 21-7 Patching an asphalt pavement. (Courtesy The Asphalt Institute.)

(d) Spreading the mix



(e) Compacting the mix



(f) Straightedging the patch

FIGURE 21-7 *Continued*

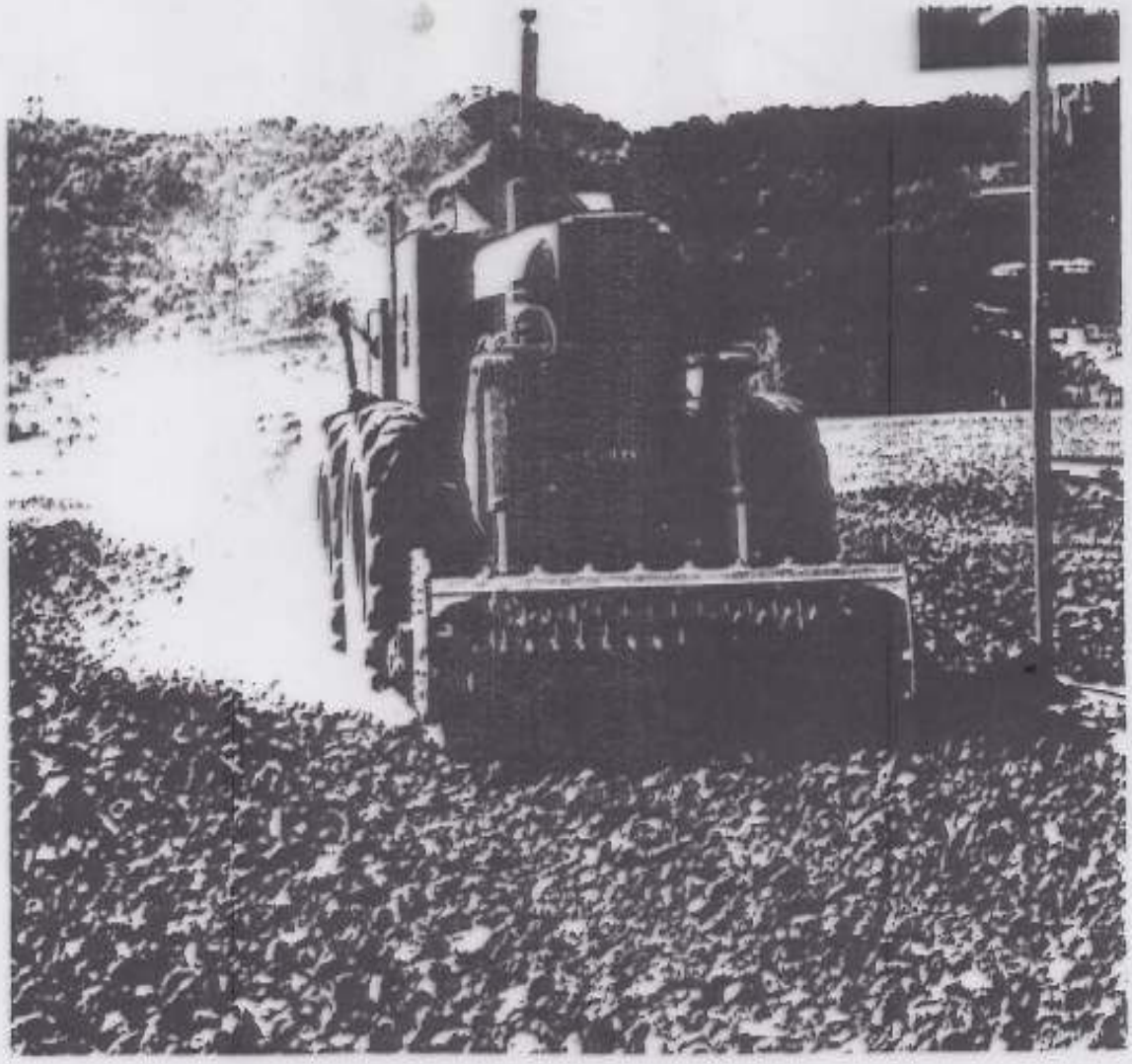


FIGURE 21-8 Compaction-cutter-crusher attachment processes an old bituminous surface. (Courtesy American Tractor Equipment Company.)

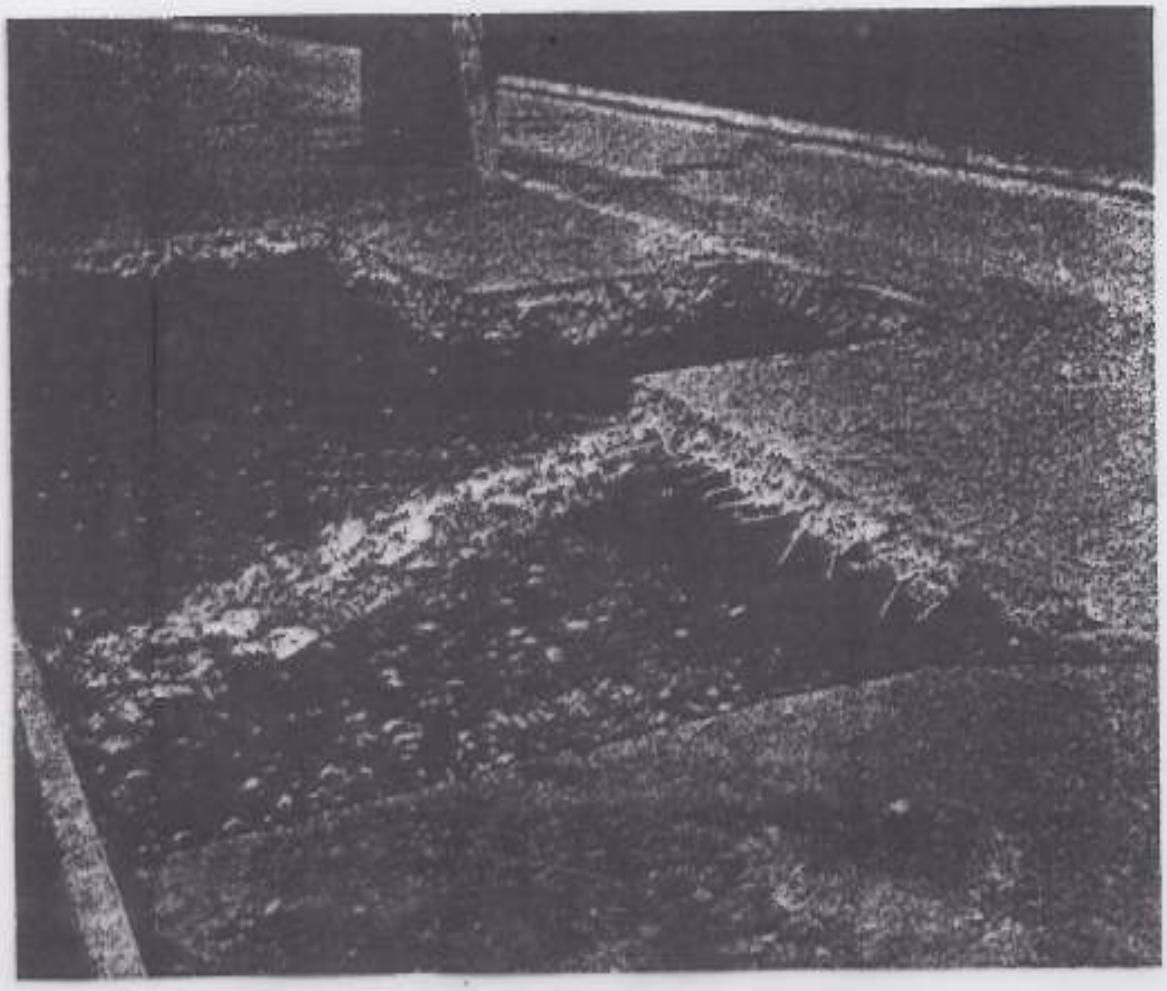


FIGURE 21-9 Concrete patching. (Courtesy Federal Highway Administration.)

Pavement maintenance:

Repairing cracks:

Alligator cracks: inter connected cracks forming and series of small blocks resembling an alligator's skin or chicken wire.

Cause: excessive deflection of surface starting from sub grade or lower course due to poor drainage.

Repair:

remove wet material
Install drainage
Apply patching to whole depth

Edge cracks: Longitudinal cracks about 1 ft or so from pavement edge with or without transverse cracks .

Cause: lack of lateral (shoulder support) .
Repair: fill cracks and apply bituminous mix to grade.

Edge joint cracks: separation of joint between the pavement and the shoulder.

Cause: poor drainage depression in pavement edge ,shoulder settlement .

Repair: in case of poor drainage improve drainage .then repair cracks.

Lane joint cracks : longitudinal separation along the seam between two paving lines.

Cause: weak bonding between adjoining spreads in the courses of the pavement .

Repair: like reflection cracks.

Reflection cracks: cracks in the AC overlay which are reflected from crack pattern in understanding layer of AC or CC or cement treated base.

REFLECTION CRACKS

Cause: untreated previous or newly formed cracks in underlying layer are brought on to AC overlay by expansion and contraction with temperature and moisture changes .

GENERAL CRACK Repair:

-Small cracks < 3 mm wide: too small to fill

- Apply fog seal

-Cracks >3mm are filled with asphalt emulsion slurry or asphalt-sand mix

-Cracks of 6mm-25 mm width: are filled with mix of 50% asphalt+ 50% sand

- Cracks >25 mm width;

- **Make trench 100-150mm wide & depth of full surface longer**
- **Fill any cracks at bottom of trench**
- **Clear through & tack coat it .**
- **Fill trench with suitable AC surface mix and compact with roller. Finish to grade**

Shrinkage cracks: inter connected forming a series of large blocks, usually with sharp corners or angles.

Cause: volume change in asphalts mix in base or sub grade , particnlary in pavement having higher proportion of low penetration asphalt. Lack of traffic hastens shrinkage cracking .
Repair:
Fill cracks as earlier
Then slung seal or
Surface treatment

Distortion: channels (ruts):channelized depression which may develop in wheel track of an AC pvt.

Cause: consolidation or lateral movement under wheel loading due to inadequate initial compaction .

Repair: level with filling by hot

Channel repair:
Level with hot plant mixed AC
Finish with a thin overlay

Corrugation and shoving :
Plastic movement of AC surface like ripples or localized bulging of pavement .

Cause: lack of stability of AC mix such as higher fines in mix or softer asphalt.

Repair : case of thin AC surface and base: scarify, remix and compact .

Case of thicker AC surface and shallow corrugation :plane with pavement placing machine ,finish the surface with seal coat /thin overlay.

Depression: like rut repair .

Utility cut depression: depression from a cut for utility installation or repair .
Cause: lack of adequate compaction of backfill .
Repair: as depression or rut .

Disintegration:
Potholes: local disintegration leading to bowl-shaped holes.

Cause: weakness due to too little asphalt, too thin AC surface, failure of base or poor drainage .

Repair: proper patching .

Raveling: progressive separation of aggregate leading to surface erosion like look.

Cause: lack of compaction ,lack of bitumen ,overheating AC mix ,dirty aggr.
Repair: surface treatment .

Skid hazard:
Bleeding asphalt
Too rich mix
Too heavy prime /tack coat .

Repair: repeated application of hot sand ,rock screenings. To blot up excess asphalt.

Can use pvt planning machine to remove excess asphalt.

Loss of cover aggregate:
Due to improper construction practice
Delay in aggr.spreading
Wet aggr.
Use of Too dusty aggr.

Bituminous pavement recycling Involves:

- **Removing existing pavement to full /partial depth**
- **Reducing the reclaimed material to suitable size for reprocessing .**
- **Blending reclaimed material with virgin aggregates and liquid asphalts**
- **Relaying the materials as base /SBWC**

Advantages:

1. **Economy**
2. **Conservation of natural resources**
3. **Improvement of pavement strength without little /no change in thickness .**
4. **correction of deficiencies in pavement mix .**

Maintenance of concrete pavement :

- **Filling and sealing joints and cracks in pavement surface .**
- **Repairing spalled ,sealed and map – cracked areas .**
- **Patching**
- **Repairing of damaged areas.**
- **Treating buckled pavement.**