二、 Project Survey and Distress Identification

Readings: Training Course - Module 2A & 2F

◎ If you are responsible for the rehabilitation of project:

※ What information / data would you need?

- must or should ?
- Table in page 219 (Must: pavement design, distress, traffic control options)

※ What are the problems?

- causes & extent ? (extended problems)

※ What are possible solutions?

- design (cost estimate) / construction ?

◎ Distress Identification

1. Type: cause, visual pattern
2. Severity: low, medium, high
3. Amount: %Area, ft/mile, m/km, no./mile

Figure 1 - Example of fatigue cracking definition

※ Available Distress Identification Manuals:

- Toward standardization
- ASTM D5340 (e.g., Figure X1.2 - X1.10)
- "Distress Identification Manual for the Long-Term Pavement Performance Studies"

Figure 10 - general AC pavement distresses
Figure 11 - general JCP pavement distresses
Figure 12 - general CRCP pavement distresses

Data Required	Full-Depth Repair	Partial-Depth Patching	Overlay	Grinding	Recycling	Undersealing	Slab Jacking	Subdrains	Joint Resealing	Pressure Relief Joints	Load Transfer Restoration	Surface Treatment
Pavement Design	●	●	●	●	●	●	●	●	●	●	●	●
Original Construction Data	o		o	o	o			o	o	o	o	
Age	o	o	o	o	o			o				o
Materials Properties	o	o	●	●	●	o		●				
Subgrade			●		●	o	o	●	●			
Climate			●		o	●		●	●	o		●
Traffic Loadings and Volumes	●		●	●	●	o		●	o	o	●	●
Distress	●	●	●	●	●	●	●	●	●	●	●	●
Skid			o	o	o							o
Accidents			o	o	o							
NDT	o		●		o	●					●	o
Destructive Testing and Sampling	●	●	●	o	●	o					o	
Roughness			o	o	o		o					o
Surface Profile				●			o					
Drainage	●		●	●	●	●		●	●			o
Previous Maintenance	o		o	o	o	o		o	o	o		o
Bridge Pushing									●	●		
Utilities	●		●		●	o	o	o				
Traffic Control Options	●	●	●	●	●	●	●	●	●	●	●	●
Vertical Clearances			●		●							
Geometrics			o		o							

KEY: ● Definitely Needed o Desirable

Name of Distress: Alligator or Fatigue Cracking

Description: Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface (or stabilized base) under repeated traffic loading. The cracking initiates at the bottom of the asphalt surface (or stabilized base) where tensile stress and strain is highest under a wheel load. The cracks propagate to the surface initially as one or more longitudinal parallel cracks. After repeated traffic loading the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are usually less than 1 foot on the longest side. Alligator cracking occurs only in areas that are subjected to repeated traffic loadings. Therefore, it would not occur over an entire area unless the entire area was subjected to traffic loading. Alligator cracking does not occur in asphalt overlays over concrete slabs. Pattern-type cracking which occurs over an entire area that is **not** subjected to loading is rated as block cracking which is not a load-associated distress. Alligator cracking is considered a major structural distress.

Severity Levels:

L*- Longitudinal disconnected hairline cracks running parallel to each other. The cracks are not spalled. Initially there may only be a single crack in the wheel path (defined as Class 1 cracking at AASHO Road Test).

M*- Further development of low-severity alligator cracking into a pattern of pieces formed by cracks that may be lightly surface spalled. Cracks may be sealed (defined as Class 2 cracking at the AASHO Road Test).

H*- Medium alligator cracking has progressed so that pieces are more severely spalled at the edges and loosened until the cells rock under traffic. Pumping may exist (defined as Class 3 cracking at the AASHO Road Test).

How to Measure: Alligator cracking is measured in square feet or square meters of surface area. The major difficulty in measuring this type of distress is that many times two or three levels of severity exist within one distressed area. If these portions can be easily distinguished from each other, they should be measured and recorded separately. If the different levels of severity cannot be easily divided, the entire area should be rated at the highest severity level present.

* L: Low severity, M: Medium severity, H: High severity

Figure 1. Example of Alligator or Fatigue Cracking Definition (1).

however, the different levels of severity in a portion of a crack cannot be easily divided, that portion should be rated at the highest severity level present.

X1.1.4 If "alligator cracking" and "rutting" occur in the same area, each is recorded at its respective severity level.

X1.1.5 If "bleeding" is counted, "polished aggregate" is not counted in the same area.

X1.1.6 "Block cracking" includes all of the "longitudinal and transverse cracking" within the area; however, "joint reflection cracking" is recorded separately.

X1.1.7 Any distress, including cracking, found in a patched area is not recorded; however, its effect on the patch is considered in determining the severity level of the patch.

X1.1.8 A significant amount of polished aggregate should be present before it is counted.

X1.1.9 Conducting a PCI survey immediately after the application of surface treatment is not meaningful, because surface treatments mask existing distresses.

X1.1.10 A surface treatment that is coming off should be counted as "raveling".

X1.1.11 A distress is said to have "foreign object damage" (FOD) Potential when surficial material is in a broken or loose state such that the possibility of ingestion of the material into an engine is present, or the potential for freeing the material due to trafficking is present.

X1.1.12 Sections X1.1.1 to X1.1.11 are not intended to be a complete list. To properly measure each distress type, the inspector must be familiar with its individual measurement criteria.

X1.2 *Alligator or Fatigue Cracking:*

X1.2.1 *Description*—Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphaltic concrete (AC) surface under repeated traffic loading. The cracking initiates at the bottom of the AC surface (or stabilized base) where tensile stress and strain are highest under a wheel load. The cracks propagate to the surface initially as a series of parallel cracks. After repeated traffic loading, the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are less than 2 ft (0.6 m) on the longest side.

X1.2.2 Alligator cracking occurs only in areas that are subjected to repeated traffic loadings, such as wheel paths. Therefore, it would not occur over an entire area unless the entire area was subjected to traffic loading. (Pattern-type cracking, that occurs over an entire area that is not subjected to loading, is rated as block cracking, that is not a load-associated distress.)

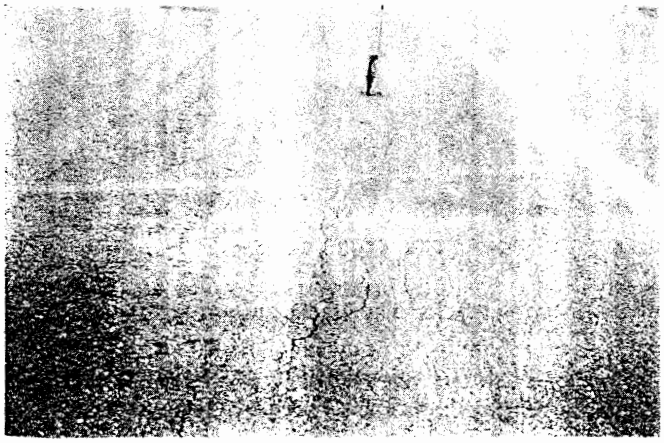

FIG. X1.1 Low-Severity Alligator Cracking

FIG. X1.2 Low-Severity Alligator Cracking

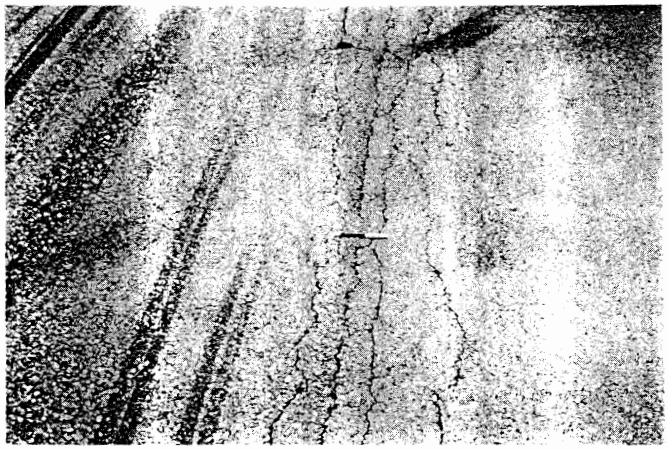

FIG. X1.3 Low-Severity Alligator Cracking, Approaching Medium Severity

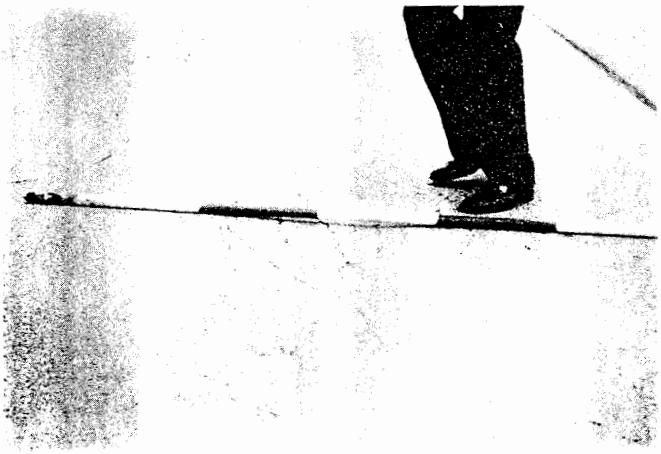

FIG. X1.4 Medium-Severity Alligator Cracking (Note the Depression Occurring with the Cracking)

FIG. X1.5 Medium-Severity Alligator Cracking

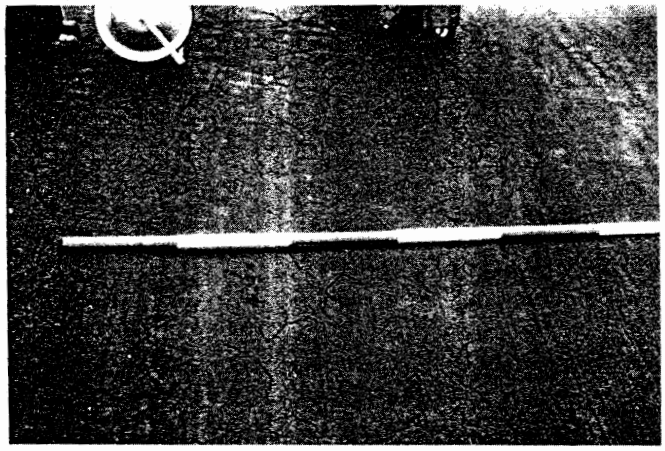

FIG. X1.6 Medium-Severity Alligator Cracking

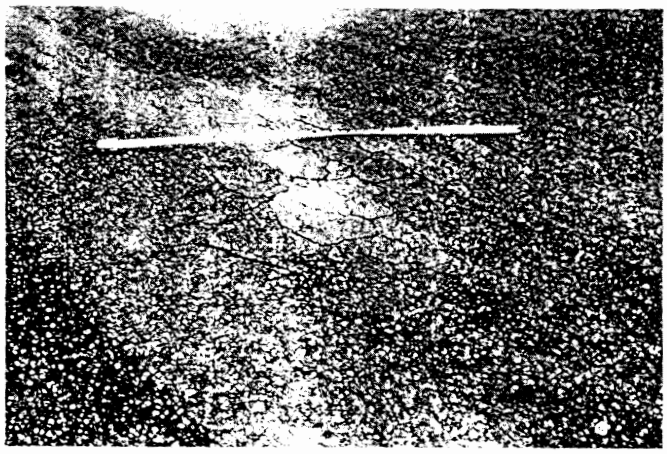

FIG. X1.7 Medium-Severity Alligator Cracking, Approaching High Severity (Example 1)

FIG. X1.8 Medium-Severity Alligator Cracking, Approaching High Severity (Example 2)

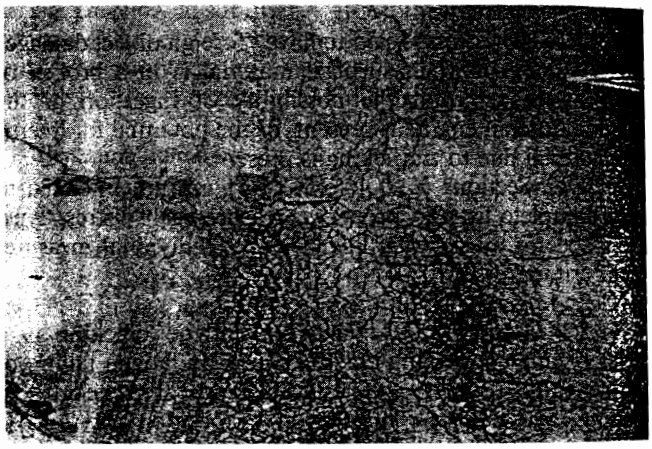

FIG. X1.9 High-Severity Alligator Cracking

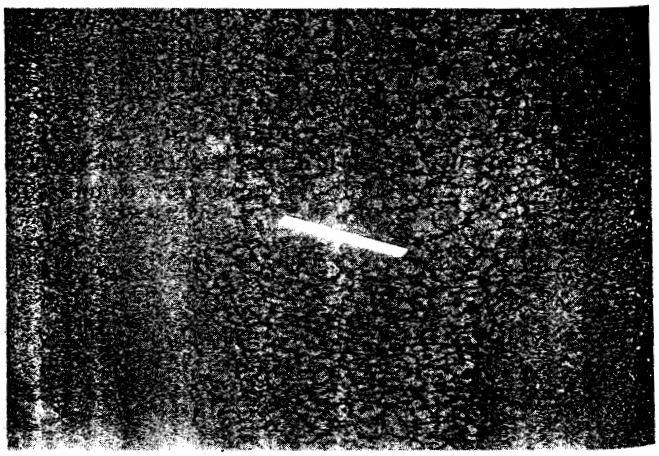

FIG. X1.10 Bleeding

X1.2.3 Alligator cracking is considered a major structural distress.

X1.2.4 *Severity Levels:*

X1.2.4.1 *L (Low)*—Fine, longitudinal hairline cracks running parallel to one another with none or only a few interconnecting cracks. The cracks are not spalled (see Figs. X1.1, X1.2, and X1.3).

X1.2.4.2 *M (Medium)*—Further development of light alligator cracking into a pattern or network of cracks that may be lightly spalled. Medium severity alligator cracking is defined by a well-defined pattern of interconnecting cracks,

	Distress Type	Primarily Traffic Load Caused	Primarily Climate/Materials Caused
1.	Alligator or Fatigue Cracking	X	
2.	Bleeding		X
3.	Block Cracking		X
4.	Corrugation		X
5.	Depression		X
6.	Joint Reflection Cracking From PCC Slab		X
7.	Lane/Shoulder Dropoff or Heave		X
8.	Lane/Shoulder Separation		X
9.	Longitudinal and Transverse Cracking,		X
10.	Patch Deterioration	X	
11.	Polished Aggregate	X (passes of tires)	
12.	Potholes	X	
13.	Pumping and Water Bleeding	X (M,H)	X (L)
14.	Raveling and Weathering		X
15.	Rutting	X	
16.	Slippage Cracking		X
17.	Swell		X

Figure 10. General Categorization of Asphalt Pavement Distress.

	Distress Type	Primarily Traffic Load Caused	Primarily Climate/Materials Caused
1.	Blow Up		X
2.	Corner Break	X	
3.	Depression		X
4.	Durability "D" Cracking		X
5.	Faulting of Transverse Joints and Cracks	X	
6.	Transverse Joint Seal Damage		X
7.	Lane/Shoulder Dropoff or Heave		X
8.	Lane/Shoulder Joint Separation		X
9.	Longitudinal Cracks		X
10.	Longitudinal Joint Faulting	X	X
11.	Patch Deterioration	X (M,H)	X (L)
12.	Patch-Adjacent Slab Deterioration	X	X
13.	Popouts		X
14.	Pumping and Water Bleeding	X (M,H)	X (L)
15.	Reactive Aggregate Distress		X
16.	Scaling, Map Cracking and Crazing		X
17.	Spalling at Transverse and Longitudinal Joints	X (M,H)	X (L,M,H)
18.	Swell		X
19.	Transverse and Diagonal Cracks	X (L,M,H)	X (L)

Figure 11. General Categorization of Jointed Concrete Pavement Distress.

	Distress Type	Primarily Traffic Load Caused	Primarily Climate/Materials Caused
1.	Asphalt Patch Deterioration	X	X
2.	Blow Up		X
3.	Concrete Patch Deterioration	X (M,H)	
4.	Construction Joint Distress		X
5.	Depression		X
6.	Durability "D" Cracking		X
7.	Edge Punchout	X	
8.	Lane/Shoulder Dropoff or Heave		X
9.	Lane/Shoulder Joint Separation		X
10.	Localized Distress		X
11.	Longitudinal Cracking		X
12.	Longitudinal Joint Faulting	X	X
13.	Patch-Adjacent Slab Deterioration	X	X
14.	Popouts		X
15.	Pumping and Water Bleeding	X (M,H)	X (L)
16.	Reactive Aggregate Distress		X
17.	Scaling, Map Cracking and Crazing		X
18.	Spalling	X	X
19.	Swell		X
20.	Transverse Cracking	X (M,H)	X (L)

Figure 12. General Categorization of Continuously Reinforced Concrete Pavement Distress.

◎ Distress Survey Procedures:

1. Identify any uniform section within project area
   (Uniform section: Identical design, traffic, others)
2. Divide section into sample units (SU)
   (20 ± 8 slabs or 2,500-5,000 ft^2)
3. Select which SU to survey (5 ~ 10%)
4. Conduct survey - distress data
   - Manual Distress Survey
   - Automated Distress Survey

◎ Automated Distress Survey

1. PASCO USA: ROADREACON-70, RDP-75
2. Automatic Road Analyzer (ARAN)
3. Swedish Laser Road Surface Tester
4. Others

◎ Roughness Survey

BPR Roughometer, May's Ride Meter, PCA Roadmeter, K.J. Law Profilometer, Drofilograph, Surface Dynamics Profilometer

◎ A.1 剛性路面損壞與維修

資料來源：

1. 李英豪、李英明，“剛性路面損壞與維修：損壞型態與原因、損壞維修，”道路工程設計與維修實務班講義，台灣省建築師公會建築研修中心，民國八十四年一月十四日。