Faculty of Engineering
Department of Civil Engineering

Maintenance of transportation networks

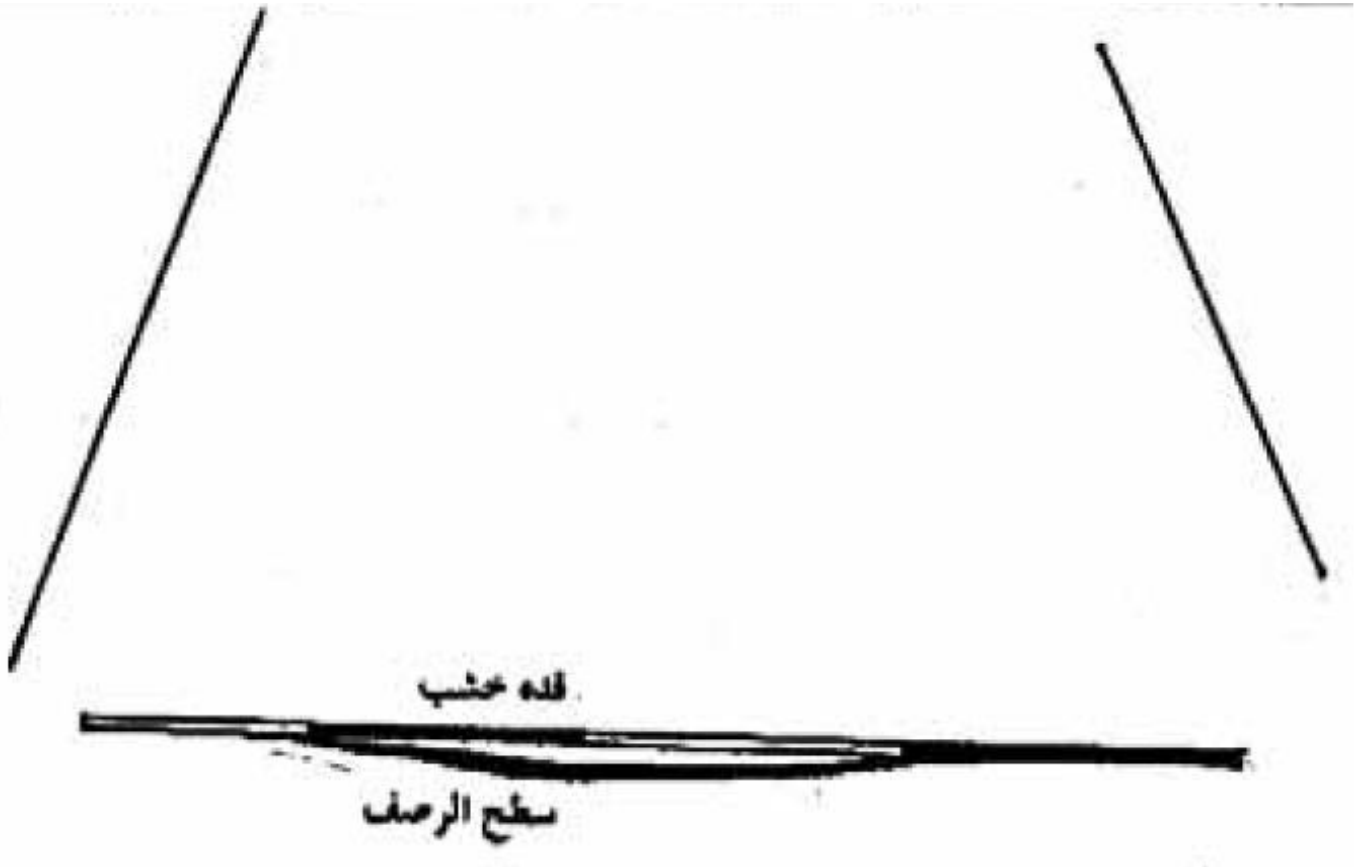
by Dr. Mahmoud Enieb

B. Depression

- Depressions are localized pavement surface areas with elevations slightly lower than those of the surrounding pavement.
- In many instances, light depressions are not noticeable until after a rain, when ponding water creates a "birdbath" area; on dry pavement, depressions can be spotted by looking for stains caused by ponding water.

- Depressions are created by settlement of the foundation soil or are a result of improper construction.
- Depressions cause some roughness, and when deep enough or filled with water, can cause hydroplaning (الانزلاق المائي)

Depression Sketch



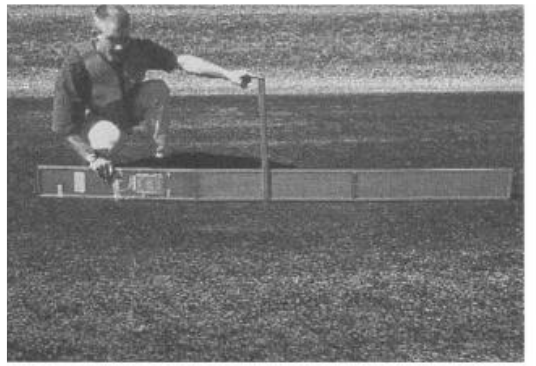
Depression Severity Levels

Maximum Depth of Depression

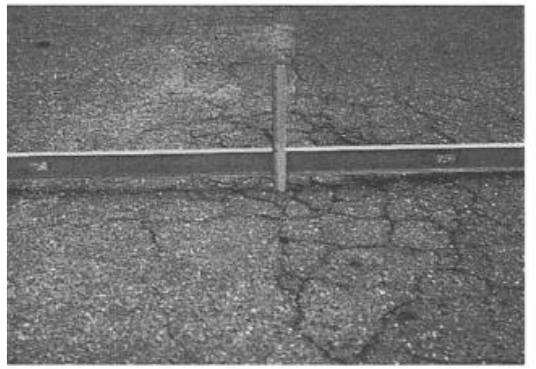
L—13 to 25 mm (1/2 to 1 in.).

M—25 to 50 mm (1 to 2 in.)

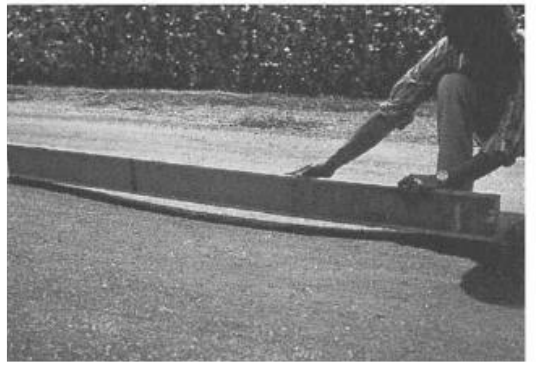
H—more than 50 mm (2 in.)



LOW



MEDIUM



HIGH

Depression

How to Measure

Depressions is measured in **square meters (feet)** of surface area.

Options for Repair

L—Do nothing.

M—Shallow, partial, or full-depth patch.

H—Shallow, partial, or full-depth patch.

Example

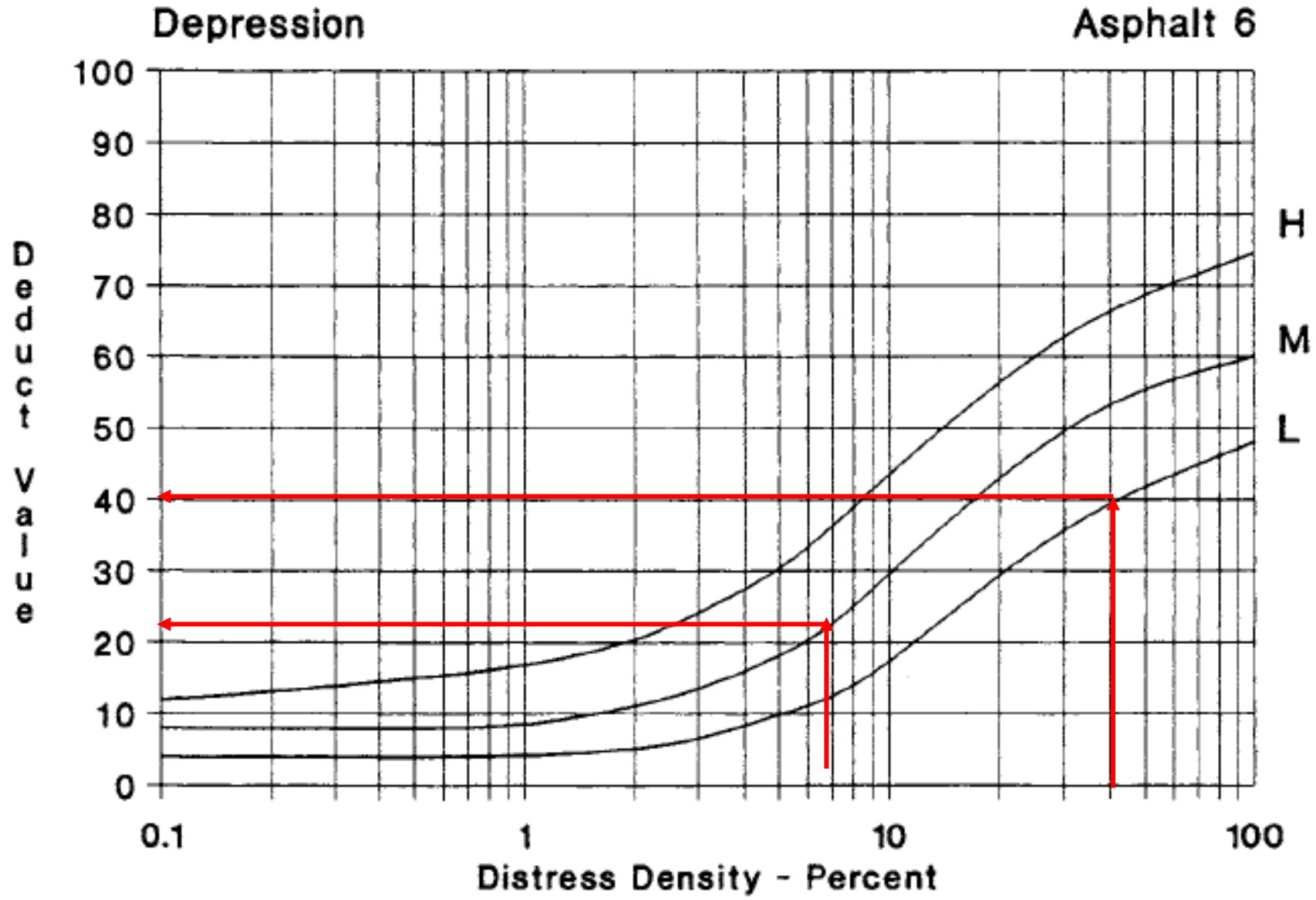
During asphalt pavement inspection of link (100*7) M, from road in Egypt, 280 m^2 low, 42 m^2 medium, depression distress type. Determine deduct value for this distress (low distress).

50 50

62 62

40 40

70 70


Depression
Asphalt 6
100
90
80
70
60
50
40
30
20
10
0
Deduct Value
H
M
L
0.1
1
10
100
Distress Density - Percent

C. Shoving

- Shoving is a permanent, longitudinal displacement of a localized area of the pavement surface caused by traffic loading. When traffic pushes against the pavement, it produces a short, abrupt wave موجة مفاجئة in the pavement surface. This distress normally occurs only in unstable liquid asphalt mix (cutback or emulsion) pavements.

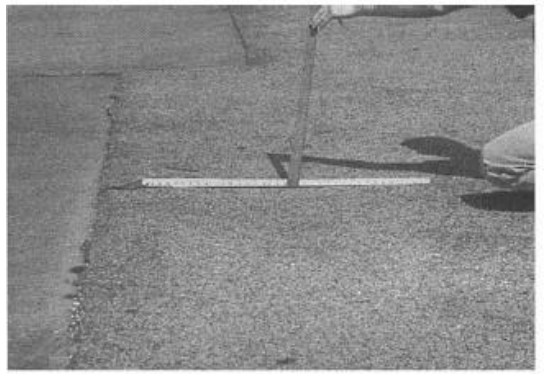
- Shoves also occur where asphalt pavements abut PCC pavements; the PCC pavements increase in length and push the asphalt pavement, causing the shoving.

Shoving Sketch

كروكى تكوم الرصف فى الاتجاه العرضى

Shoving Severity Levels

L—Shove causes low severity ride quality.

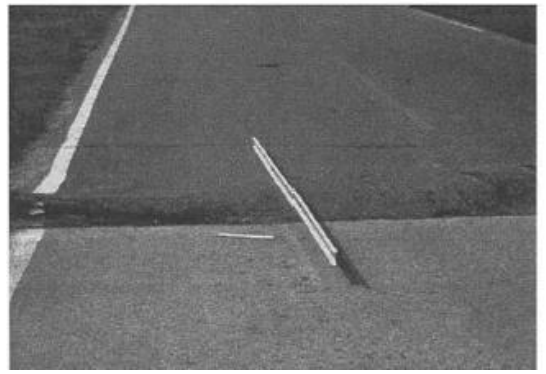


LOW

M—Shove causes medium severity ride quality.

MEDIUM

H—Shove causes high-severity ride quality.



HIGH

Shoving

How to Measure

Shoves are measured in **square meter (feet)** of surface area. Shoves occurring in patches are considered in rating the patch, not as a separate distress.

Options for Repair

L—Do nothing; Mill.

M—Mill; Partial or full-depth patch.

H—Mill; Partial or full-depth patch.

Example

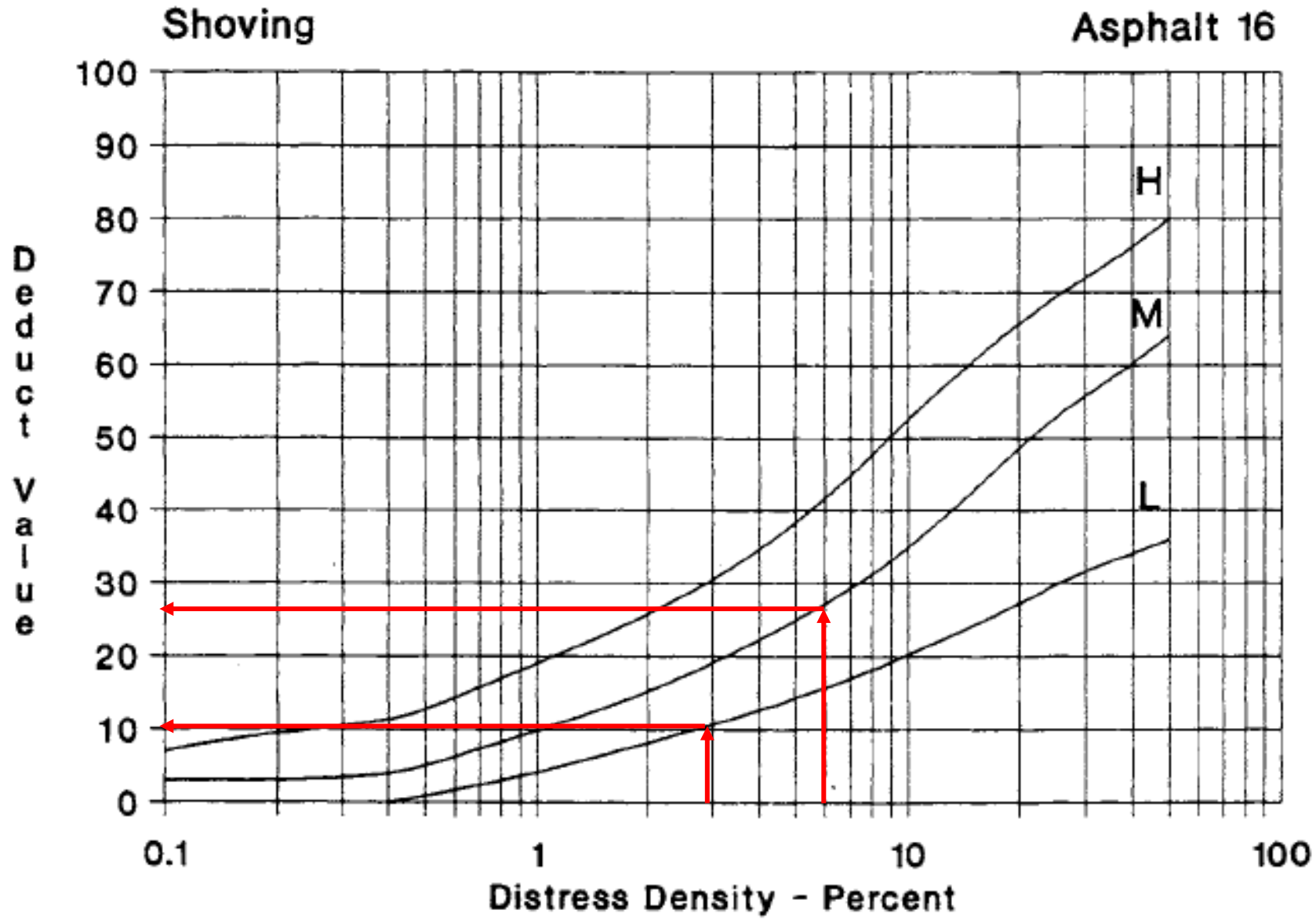
During asphalt pavement inspection of link (100*7) M, from road in Egypt, 21 m^2 low, 42 m^2 medium, shoving distress type. Determine deduct value for this (low medium) distress.

10

28

38

50


Shoving
Asphalt 16
Deduct Value
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.1
1
10
100
Distress Density - Percent

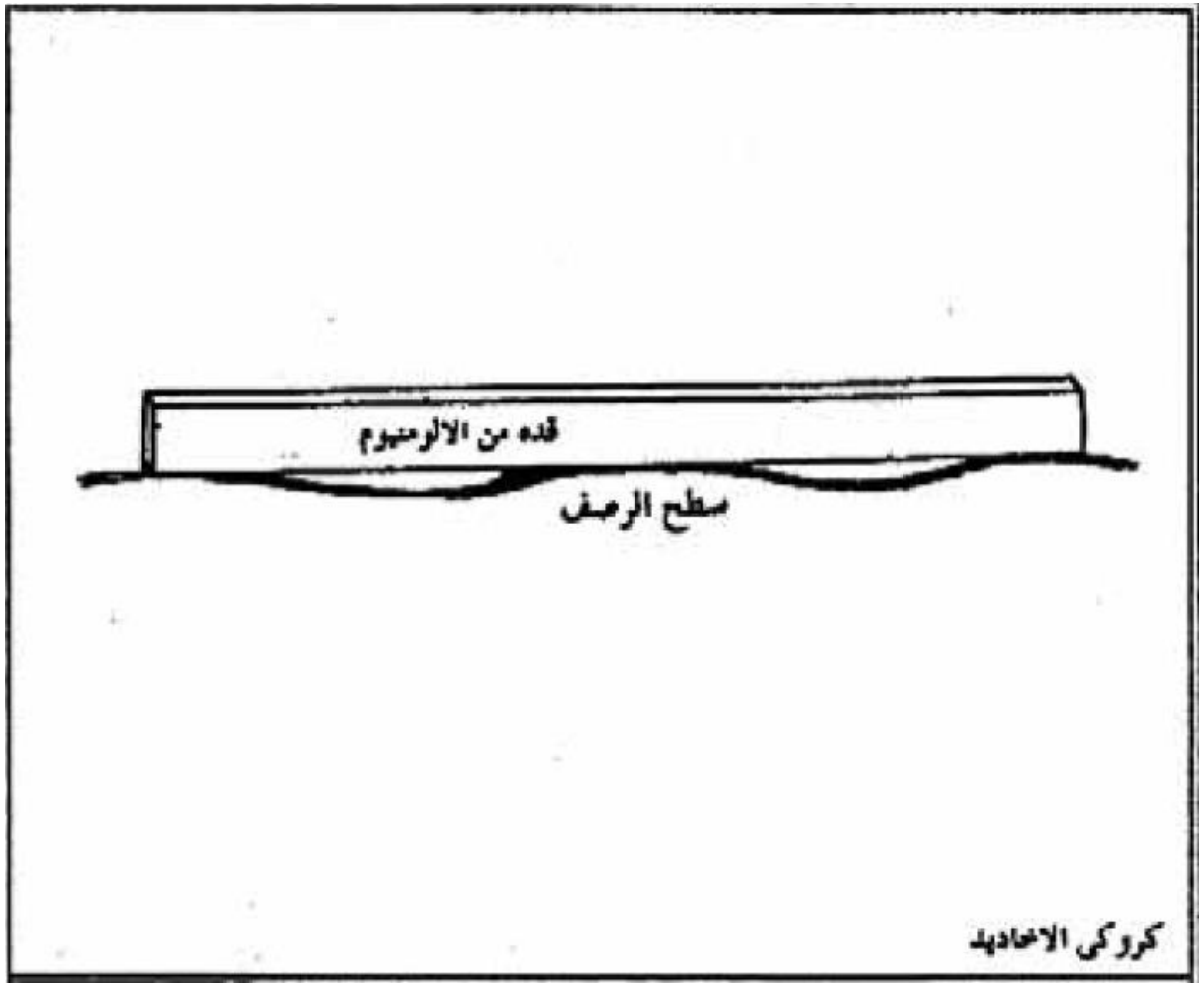
D. Rutting

- A rut is a surface depression in the wheel path. Pavement uplift may occur along the sides of the rut; however, in many instances ruts are noticeable only after a rainfall, when the wheel paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or subgrade.

- It is usually caused by consolidation or lateral movement of the materials due to traffic loads.

- Significant rutting can lead to major structural failure of the pavement.

Rutting Sketch

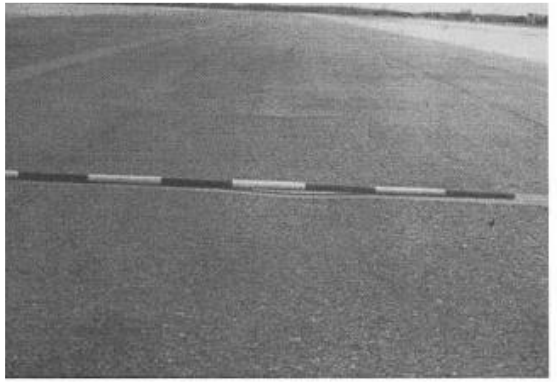


Rutting Severity Levels

L—Less than 1/4 to 1/2 in. (<6.4 to 12.7 mm).

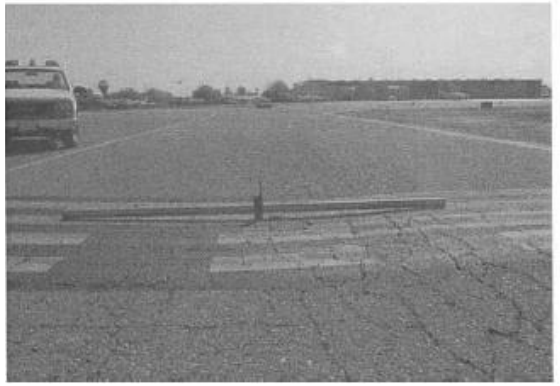
M— From 1/2 to 1 in. (12.7 to 25.4 mm).

H—Greater than 1 in. (25.4 mm.



LOW

MEDIUM



HIGH

Rutting

How to Measure

Rutting is measured in **square feet (square meters)** of surface area, and its severity is determined by the depth of the rut. To determine the rut depth, a straightedge should be laid across the rut and the maximum depth measured.
The mean depth in inches (mm) should be computed from measurements taken along the length of the rut.

Options for Repair

L—Do nothing.
M—Shallow, partial or full-depth patch; Partial or full-depth patch and overlay.
H—Shallow, partial or full-depth patch; Partial or full-depth patch and overlay.

Example

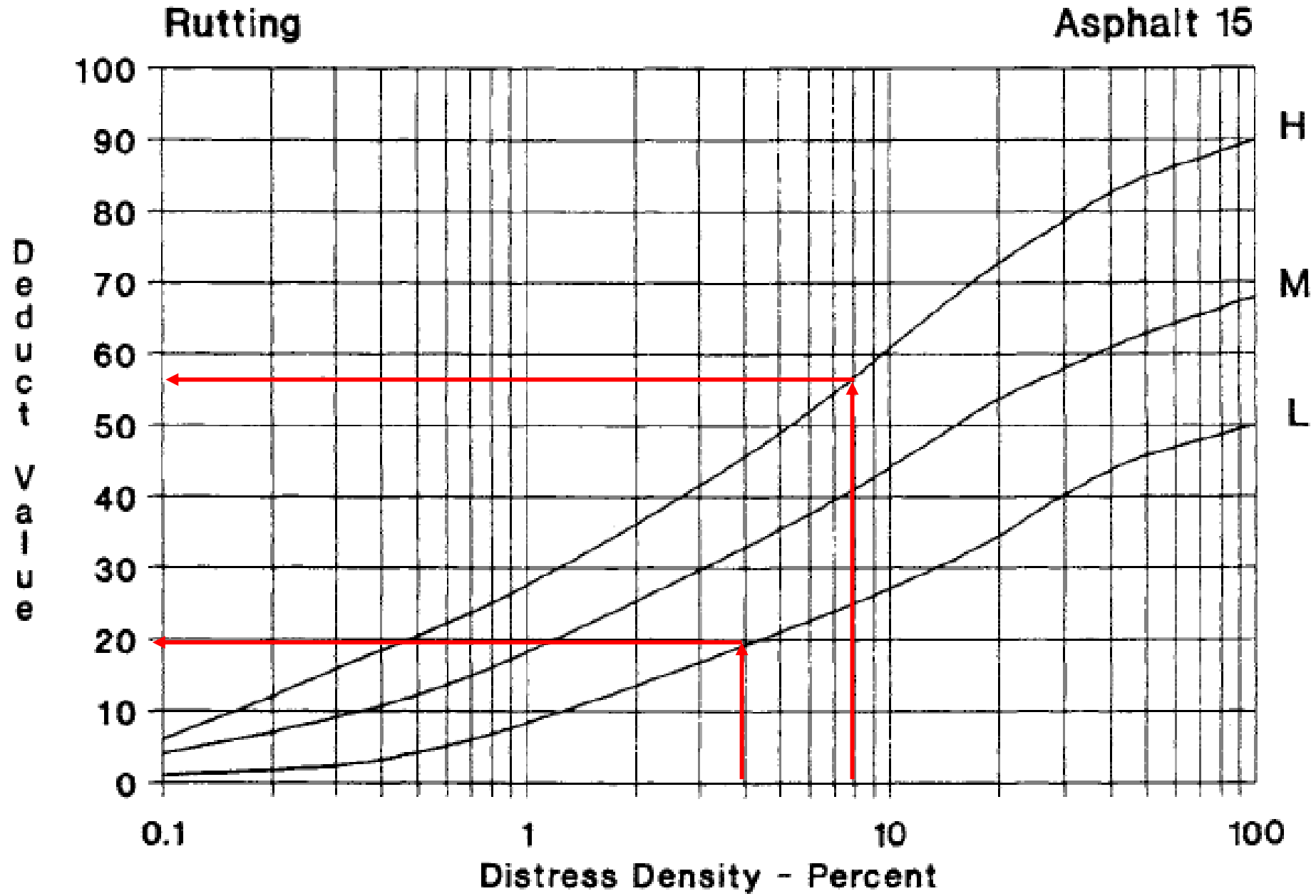
During asphalt pavement inspection of link (100*14) M, from desert road in Egypt, 56 m^2 low, 112 m^2 high, rutting distress type. Determine deduct value for this high low distress.

19

58

77

90

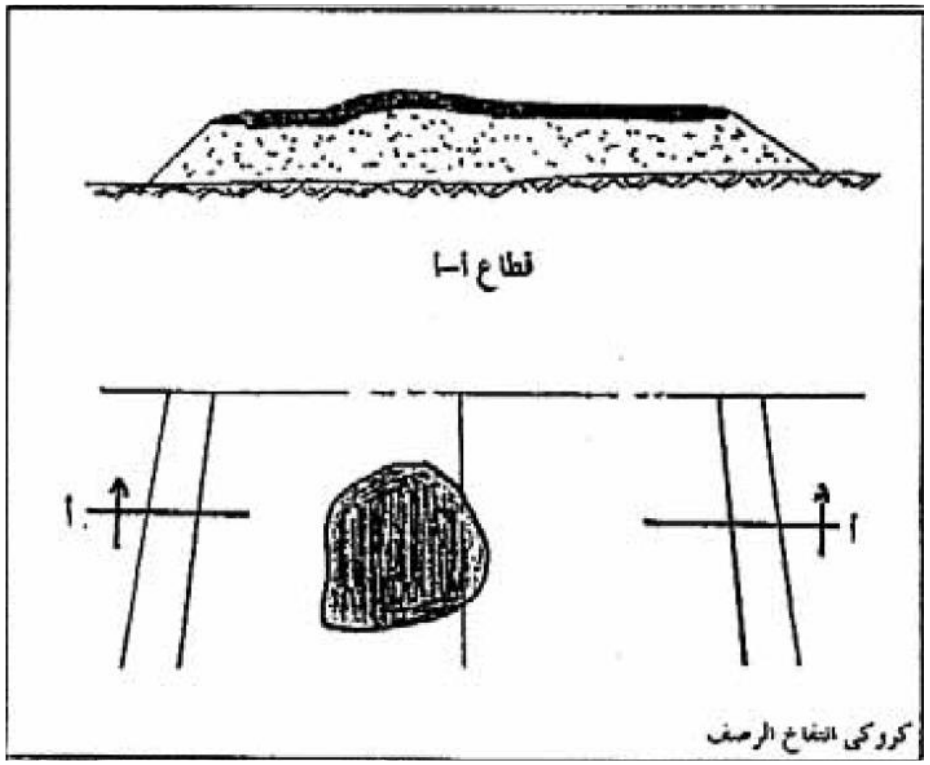

Rutting
Asphalt 15
100
90
80
70
60
50
40
30
20
10
0
Deduct Value
H
M
L
0.1
1
10
100
Distress Density - Percent

E. Swelling or upheaval

- Swell is characterized by an upward bulge in the pavement's surface—a long, gradual wave greater than 10 ft (3 m) long. Swelling can be accompanied by surface cracking.

- This distress is usually caused by frost action in the subgrade or by swelling soil.

Swelling Sketch



Swelling Severity Levels

L—Swell causes low-severity ride quality. Low-severity swells are not always easy to see but can be detected by driving at the speed limit over the pavement section. An upward motion will occur at the swell if it is present.

M—Swell causes medium severity ride quality.

H—Swell causes high severity ride quality.

LOW

MEDIUM

HIGH

swelling

How to Measure

The surface area of the swell is measured in **square feet (square meters)**.

Options for Repair

L—Do nothing.
M—Do nothing; Reconstruction
H—Reconstruction

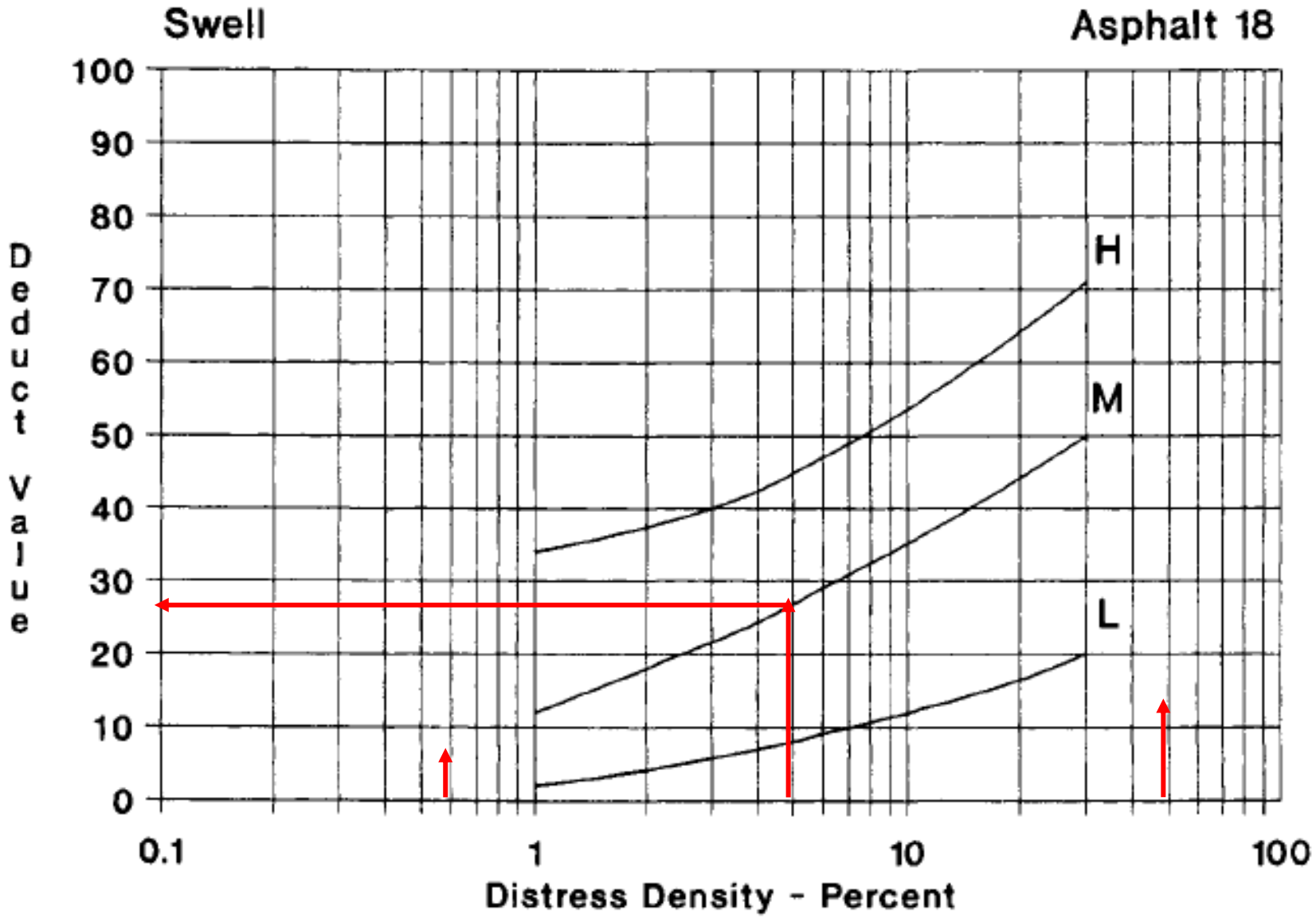
Example

During asphalt pavement inspection of link (100*14) M, from road in Egypt, 42 m^2 high, 70 m^2 medium, swelling distress type. Determine deduct value for medium distress.

40

27

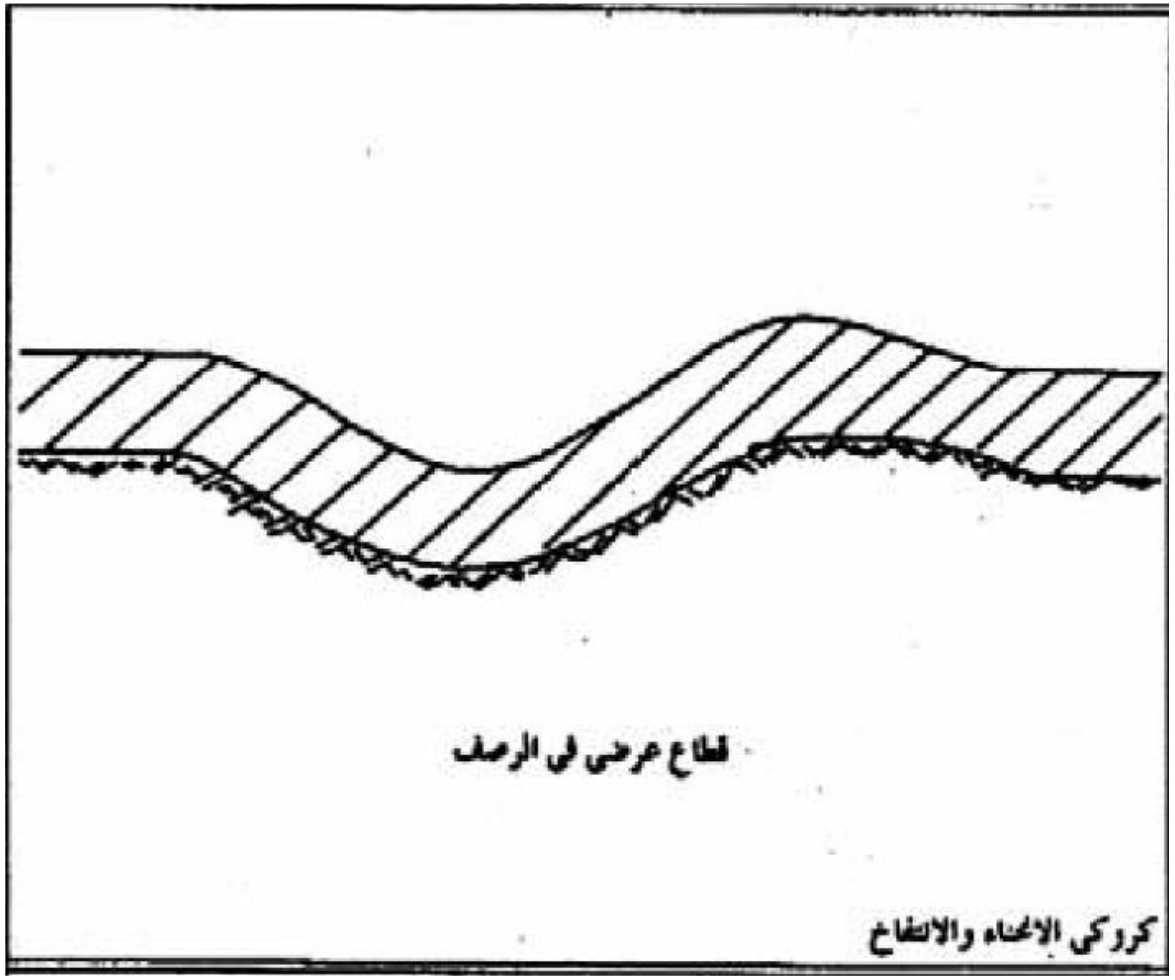
67


Swell
Asphalt 18
Deduct Value
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.1
1
10
100
Distress Density - Percent

F. Sag and Bumps

- Bumps are small, localized, upward displacements of the pavement surface. They are different from shoves in that shoves are caused by unstable pavement. Bumps, on the other hand, can be caused by several factors, including:
- 1. Buckling or bulging of underlying PCC slabs in AC overlay over PCC pavement.
- 2. Frost heave (ice).
- 3. Infiltration and buildup of material in a crack in combination with traffic loading (sometimes called "tenting").

Sag and Bumps Sketch

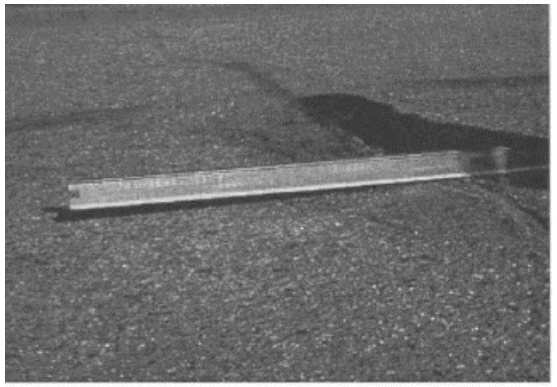


Sag and Bumps Severity Levels

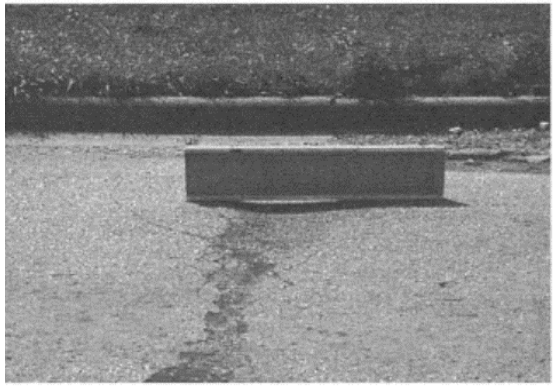
L—Bump or sag causes low severity ride quality.

M—Bump or sag causes medium severity ride quality.

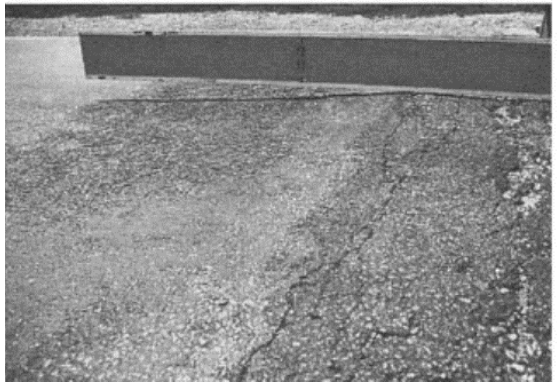
H—Bump or sag causes high severity ride quality.



LOW



MEDIUM



HIGH

Sag and Bumps

How to Measure

Bumps or sags are measured in **linear feet or meter**. If bumps appear in a pattern perpendicular to traffic flow and are spaced at <10 ft (3 m), the distress is called corrugation. If the bump occurs in combination with a crack, the crack is also recorded.

Options for Repair

L—Do nothing.
M—Cold mill; Shallow, partial or full-length patch.
H—Cold mill; Shallow, partial or full-depth patch; Overlay.

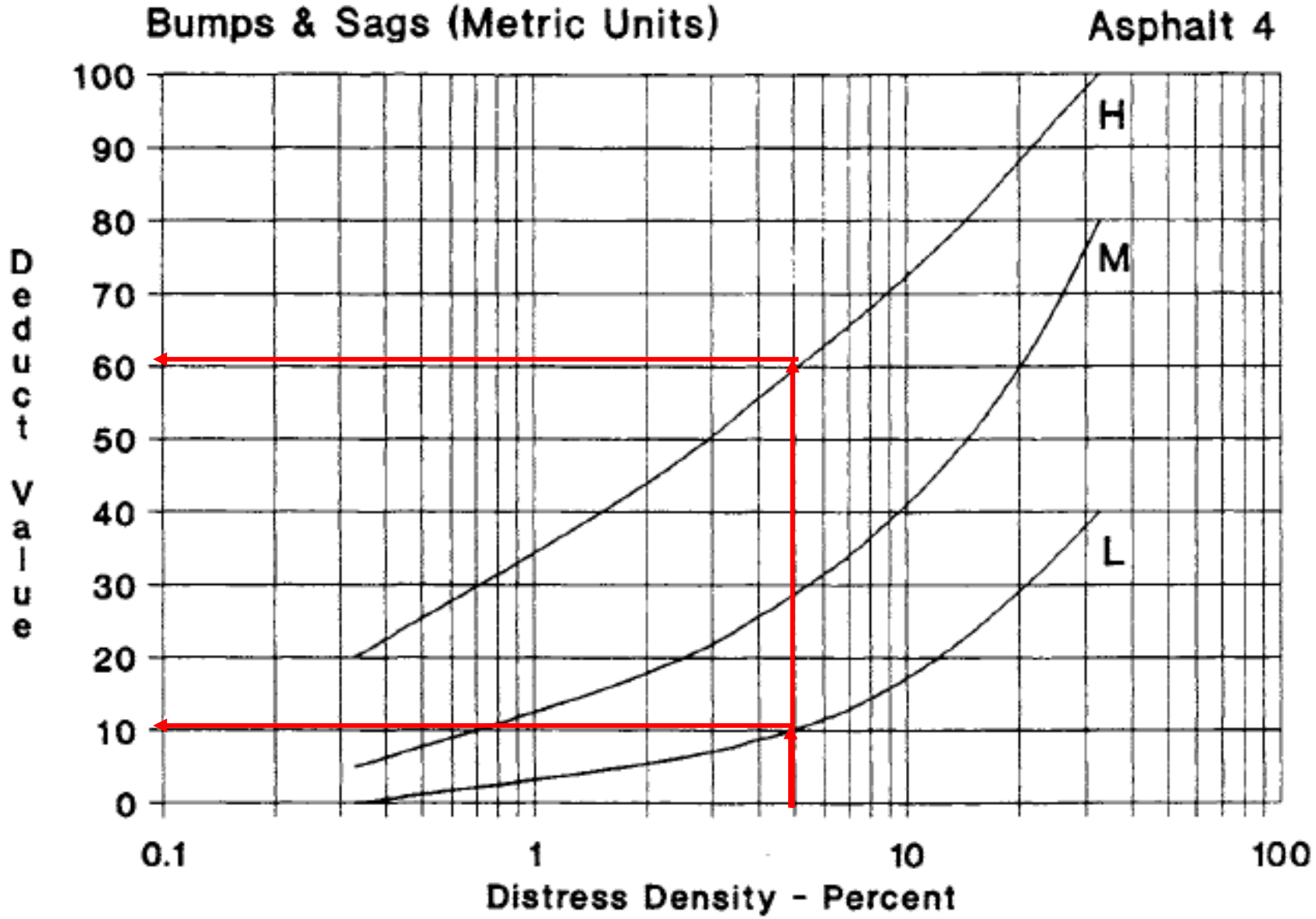
Example

During asphalt pavement inspection of link (100*20) M, from road in Egypt, 100 m low, 100 m high, Sag and bump distress type. Determine deduct value for this (High) distress.

10 10

60 60

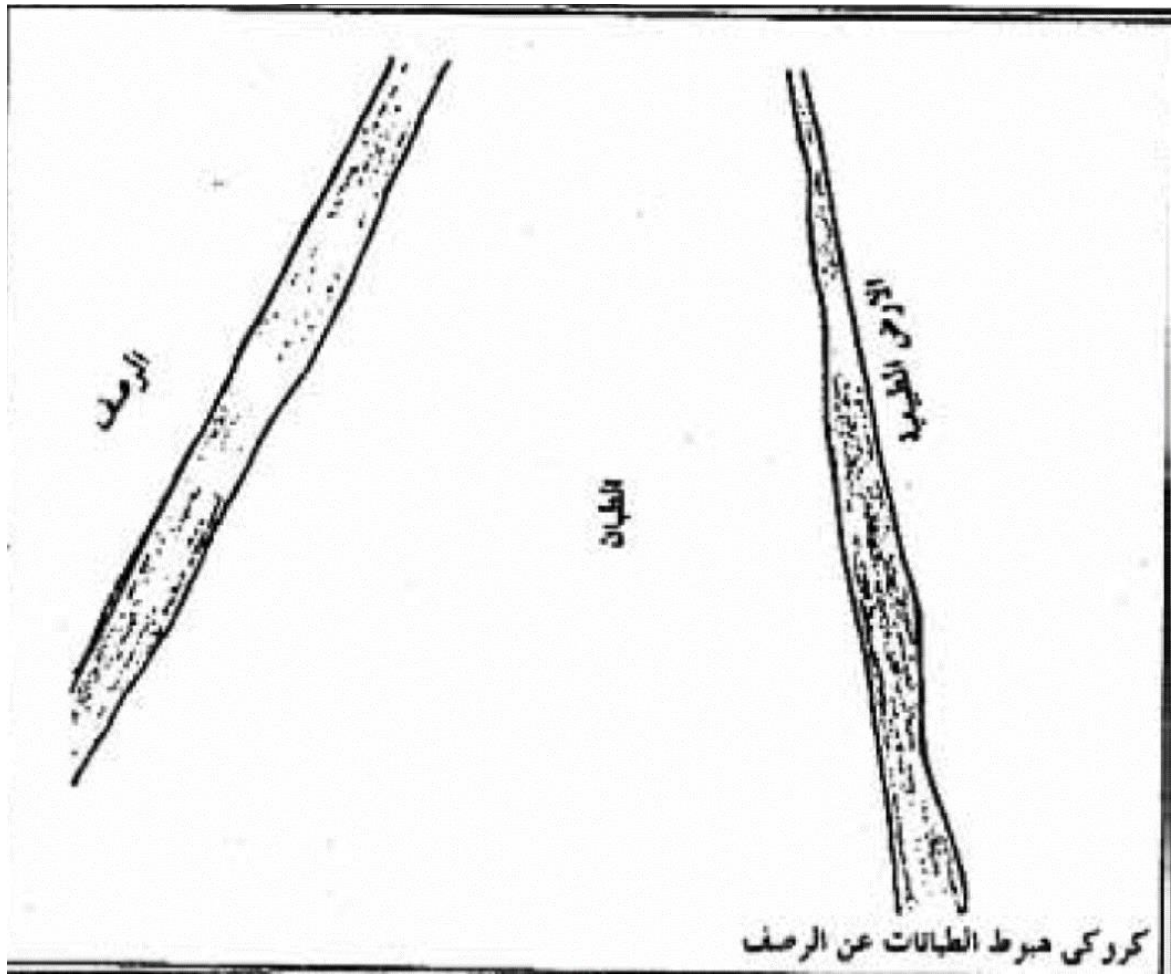
70 70


Bumps & Sags (Metric Units)
Asphalt 4
Deduct Value
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.1
1
10
100
Distress Density - Percent

K. Lane / shoulder Drop off

- Lane/shoulder drop-off is the difference between the settlement or erosion of the shoulder and the pavement travel-lane edge.
- The elevation difference can be a safety hazard; it can also cause increased water infiltration.

Lane / shoulder Drop off Sketch

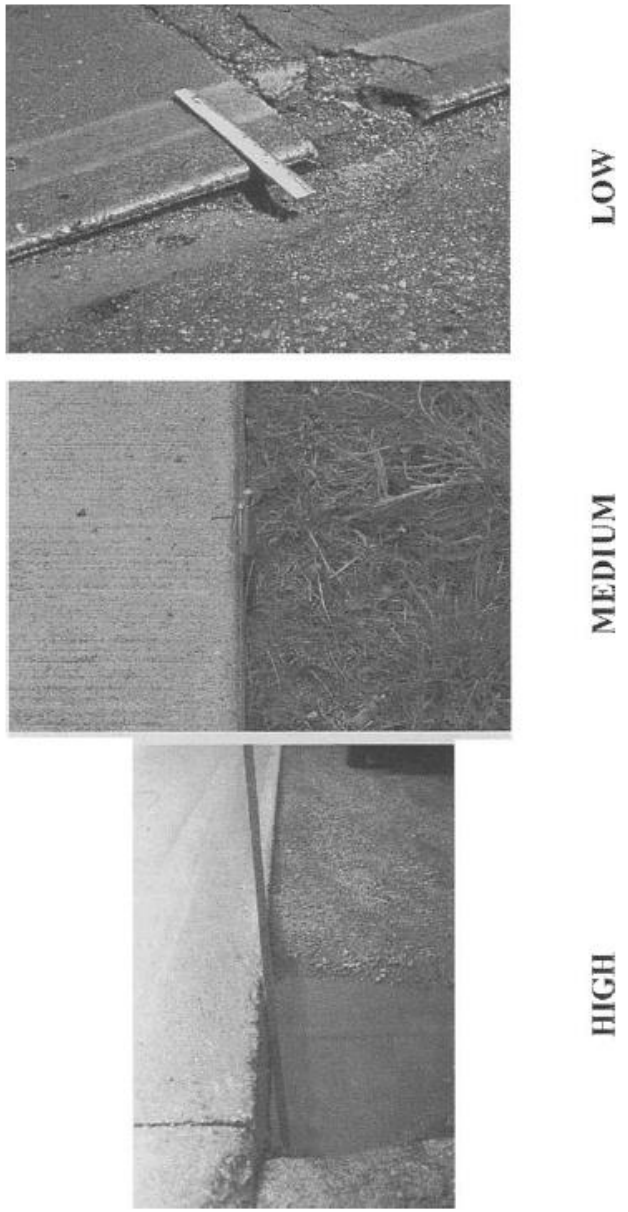


Lane / shoulder Drop off Severity Levels

L—The difference between the pavement edge and shoulder is 1 to 2 in. (25 to 51 mm).

M—The difference in elevation is 2 to 4 in. (51 to 102 mm).

H—The difference in elevation is >4 in. (102 mm



Lane / shoulder Drop off

How to Measure

Feet or meter length.

The mean lane/shoulder drop off is computed by averaging the maximum and minimum drop along the slab. Each slab exhibiting distress is measured separately and counted as one slab with the appropriate severity level.

Options for Repair

L, M, H—Regrade and fill shoulders to match lane height.

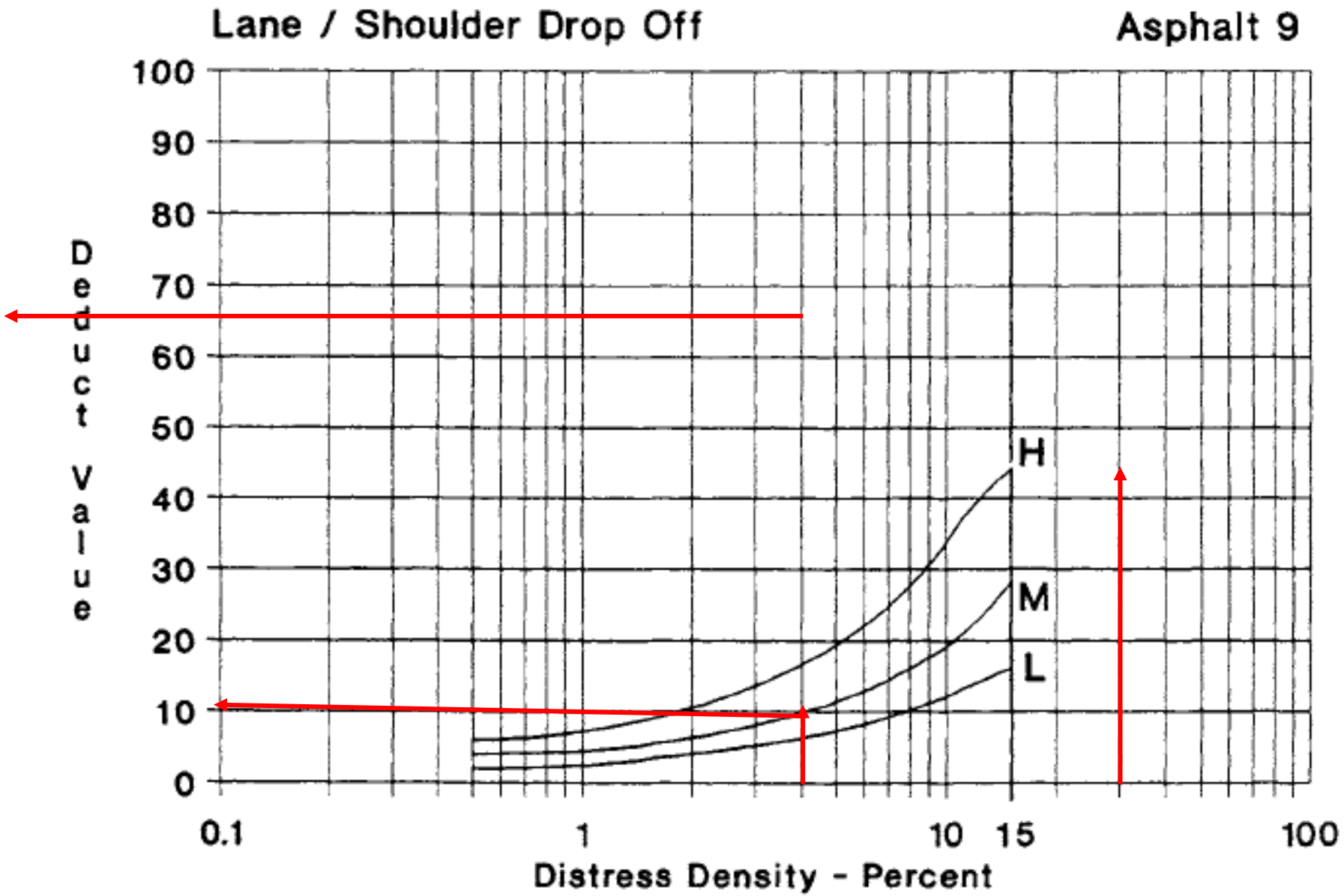
Example

During asphalt pavement inspection of link (100*10) M, from road in Egypt, 40 m medium, 300 m high, lane / shoulder drop off distress type. Determine deduct value for high distress.

44

65

54


Lane / Shoulder Drop Off
Asphalt 9
Deduct Value
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.1
1
10
15
100
Distress Density - Percent

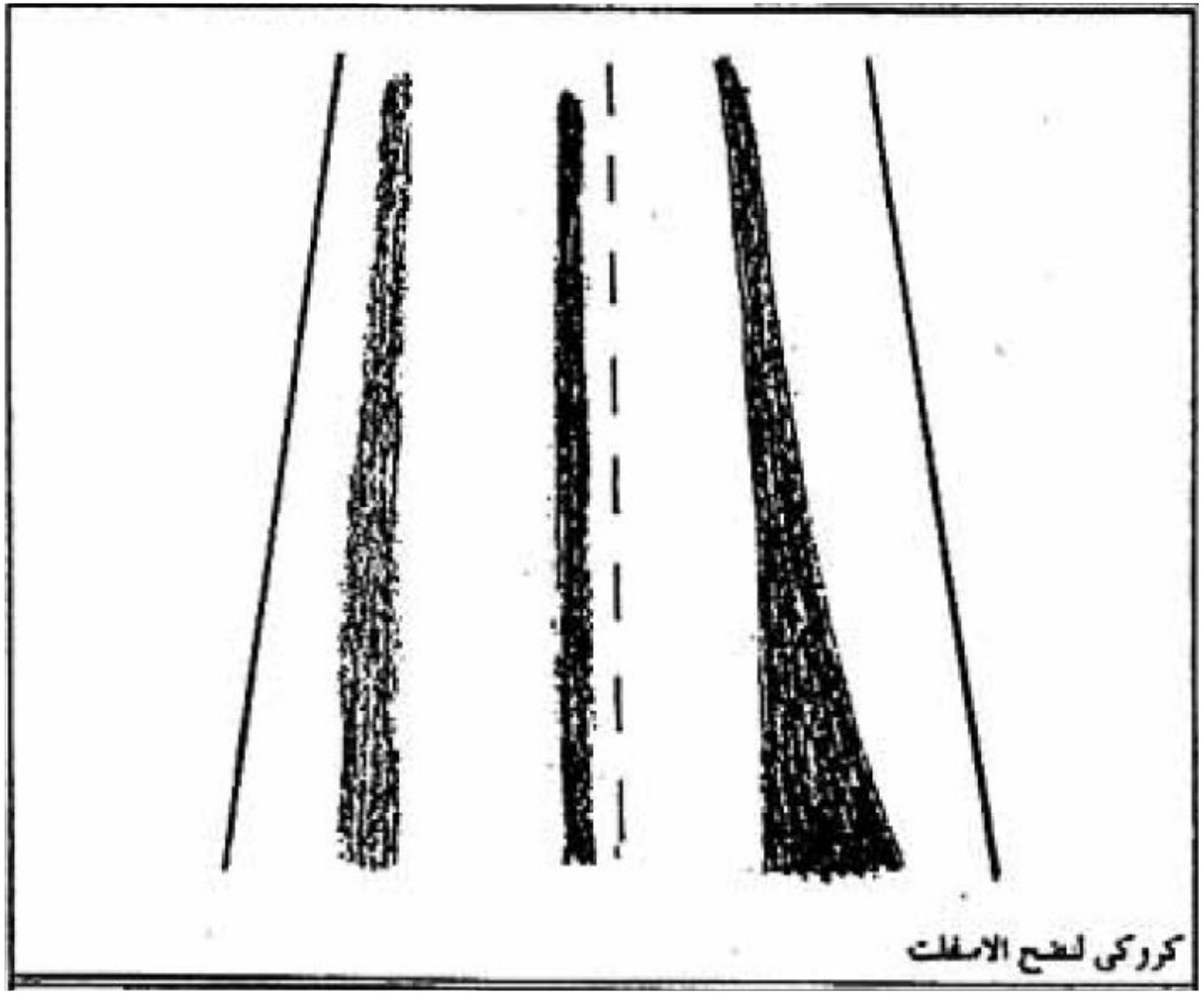
3 – Slippery Surface
عيوب ناتجة عن سطح زلق

- Bleeding.
- Polished aggregates

A. Bleeding

- Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glasslike, reflecting surface that usually becomes quite sticky.
- Bleeding is caused by excessive amounts of asphaltic cement or tars in the mix, excess application of a bituminous sealant, and/or low air void content.
- It occurs when asphalt fills the voids of the mix during hot weather and then expands into the pavement surface. Since the bleeding process in not reversible during cold weather, asphalt or tar will accumulate on the surface.

Bleeding Sketch

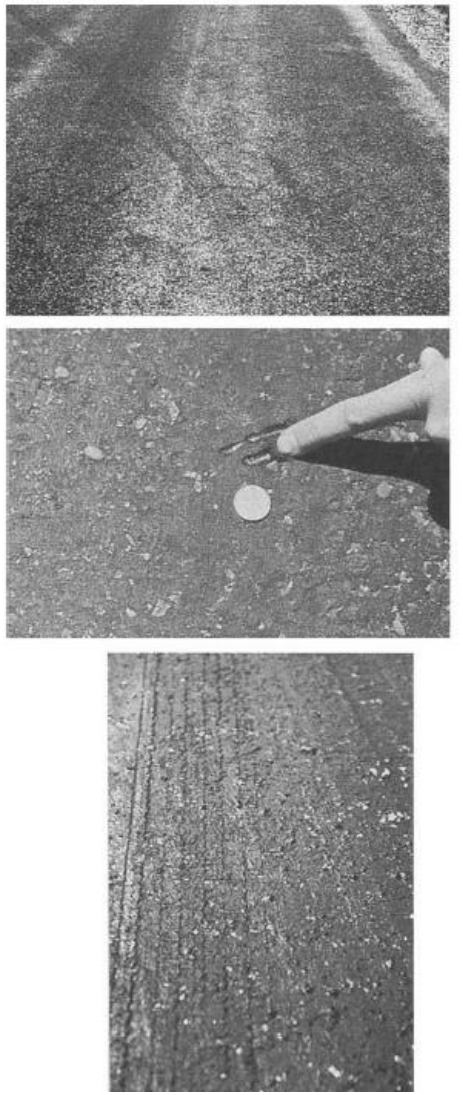


Bleeding Severity Levels

L—Bleeding has only occurred to a very slight degree and is noticeable only during a **few days of the year**. Asphalt **does not stick to shoes or vehicles**.

M—Bleeding has occurred to the extent that **asphalt sticks to shoes and vehicles** during only a **few weeks of the year.**

H—Bleeding has occurred extensively and considerable asphalt sticks to shoes and vehicles during **at least several weeks of the year.**



Bleeding

How to Measure

Bleeding is measured in **square feet or meter** of surface area. If bleeding is counted, polished aggregate should not be counted.

Options for Repair

L—Do nothing.
M—Apply sand/fine aggregate and roll.
H—Apply sand/fine aggregate and roll.

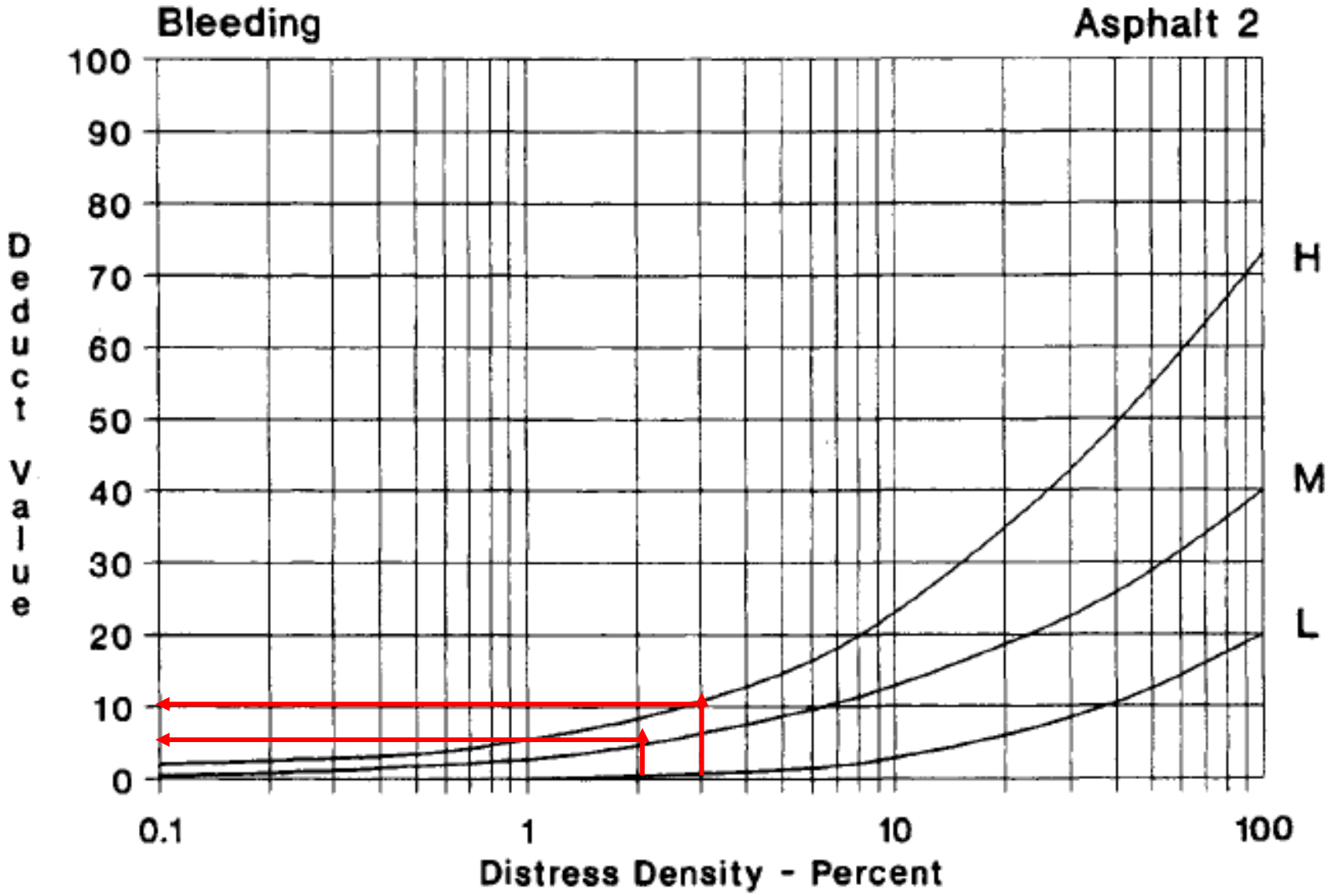
Example

During asphalt pavement inspection of link (100*5) M, from desert road in Egypt, 10 m^2 medium, 15 m^2 high, bleeding distress type. Determine deduct value for high distress.

10

5

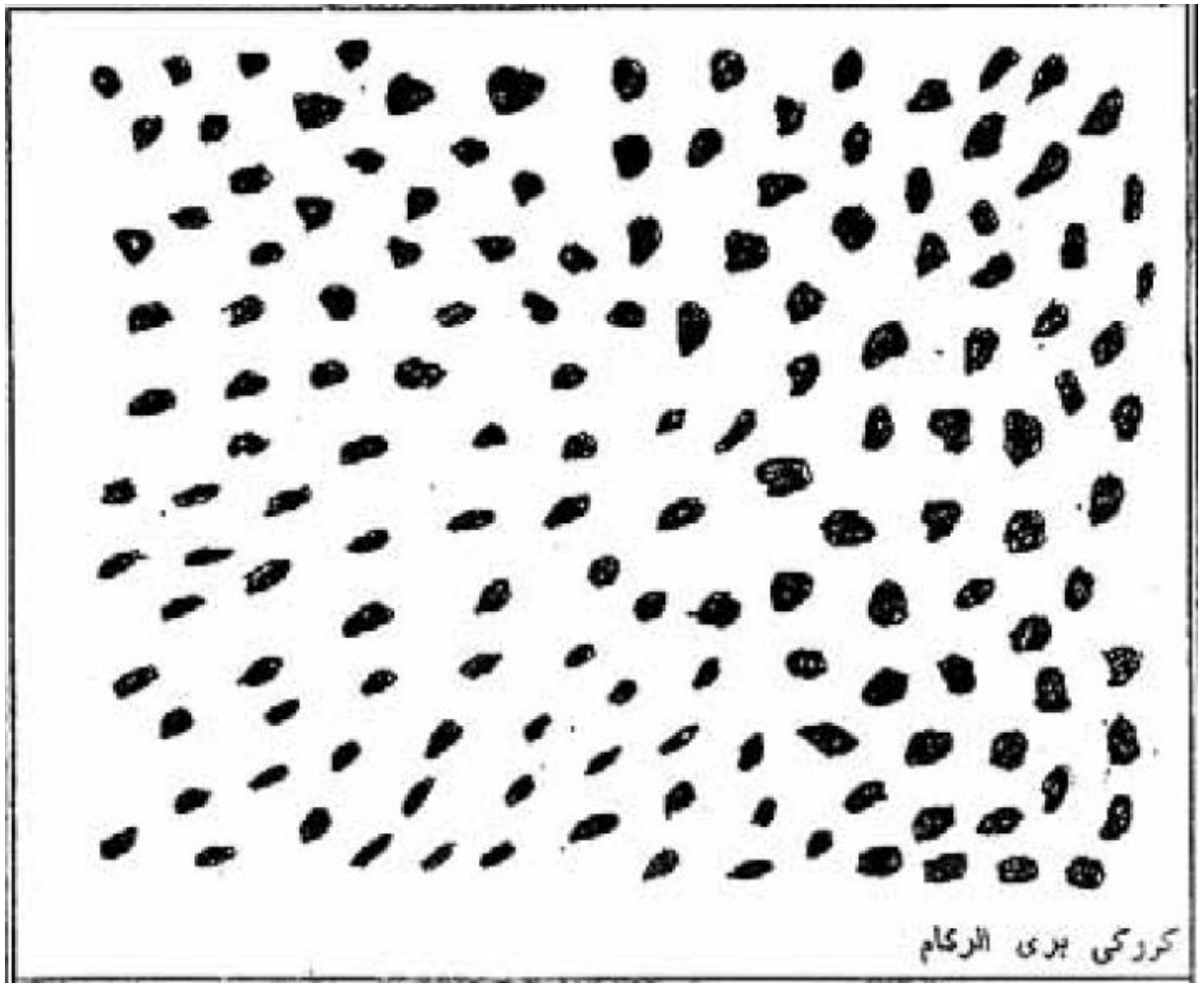
15


Bleeding
Asphalt 2
Deduct Value
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.1
1
10
100
Distress Density - Percent

B. Polished Aggregates

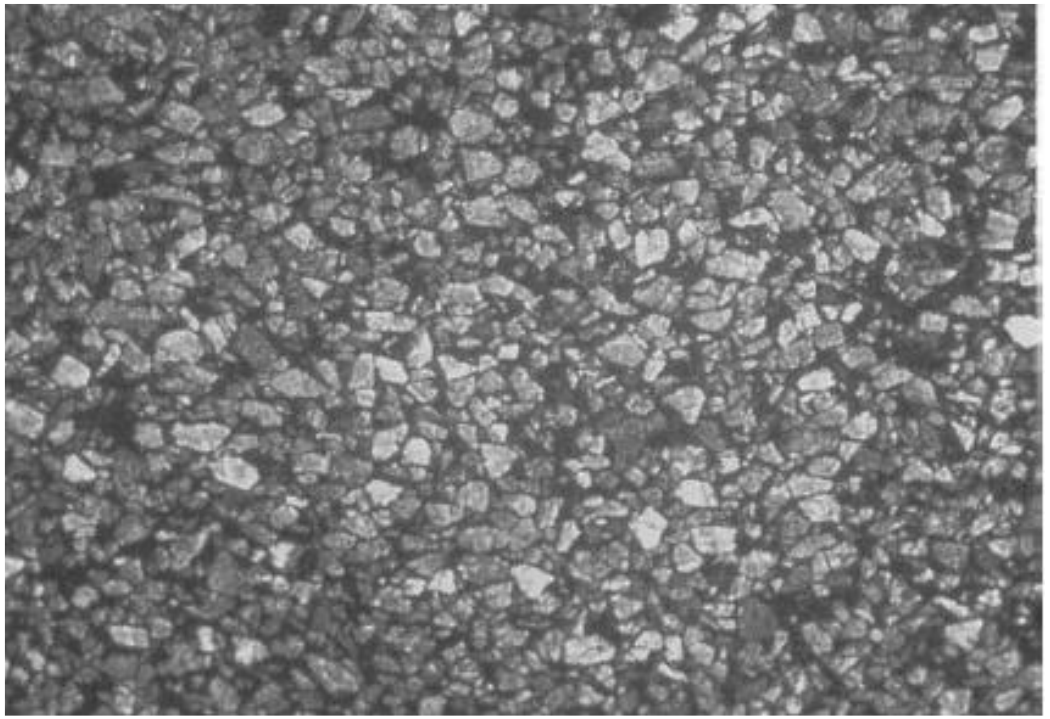
- This distress is caused by repeated traffic applications. When the aggregate in the surface becomes smooth to the touch, adhesion with vehicle tires is considerably reduced.
- When the portion of aggregate extending above the surface is small, the pavement texture does not significantly contribute to reducing vehicle speed.
- Polished aggregate should be counted when close examination reveals that the aggregate extending above the asphalt is negligible, and the surface aggregate is smooth to the touch. Excess of natural aggregate, more than 10%.
- This type of distress is indicated when the number on **a skid resistance test** is low or has dropped significantly from a previous rating

Polished Aggregates



Polished Aggregates Severity Levels

No degrees of severity are defined. However, the degree of polishing should be clearly evident in the sample unit in that the aggregate surface should be smooth to the touch.



Polished Aggregates

How to Measure

Polished aggregate is measured in **square feet or meter** of surface area. If bleeding is counted, polished aggregate should not be counted.

Options for Repair

L, M, H—Do nothing; Surface treatment; Overlay; Mill and Overlay.

Example

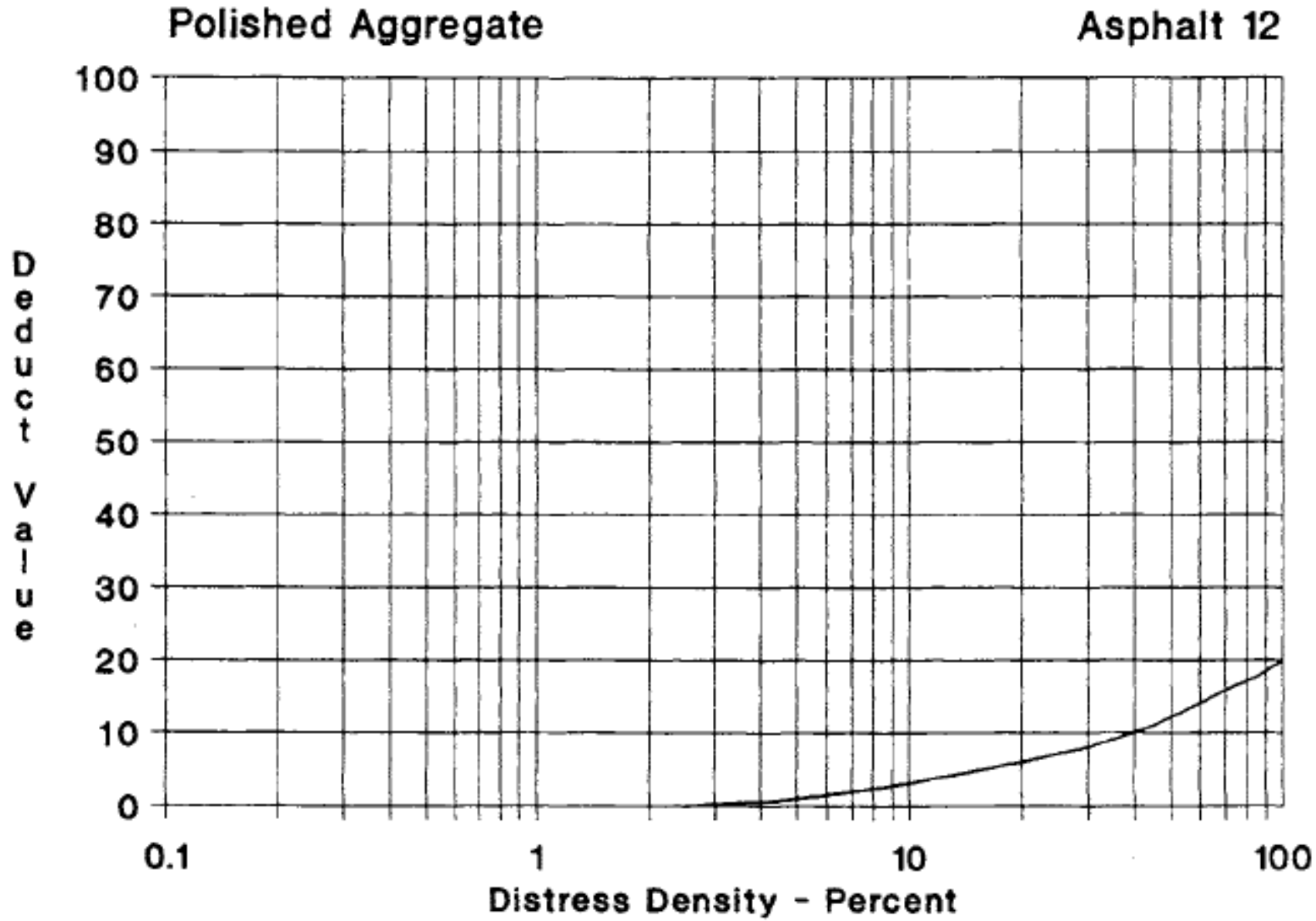
During asphalt pavement inspection of link (100*15) M, from road in Egypt, 15 m^2 high, 600 m^2 medium, polished aggregates distress type. Determine deduct value for this distress.

0

10

15

20


Polished Aggregate
Asphalt 12
100
90
80
70
60
50
40
30
20
10
0
Deduct Value
0.1
1
10
100
Distress Density - Percent

4 – Surface Disintegration
عيوب ناتجة عن تفكك سطح الرصف

- Weathering and Raveling.
- Potholes.
- Patching and utility cut patching.

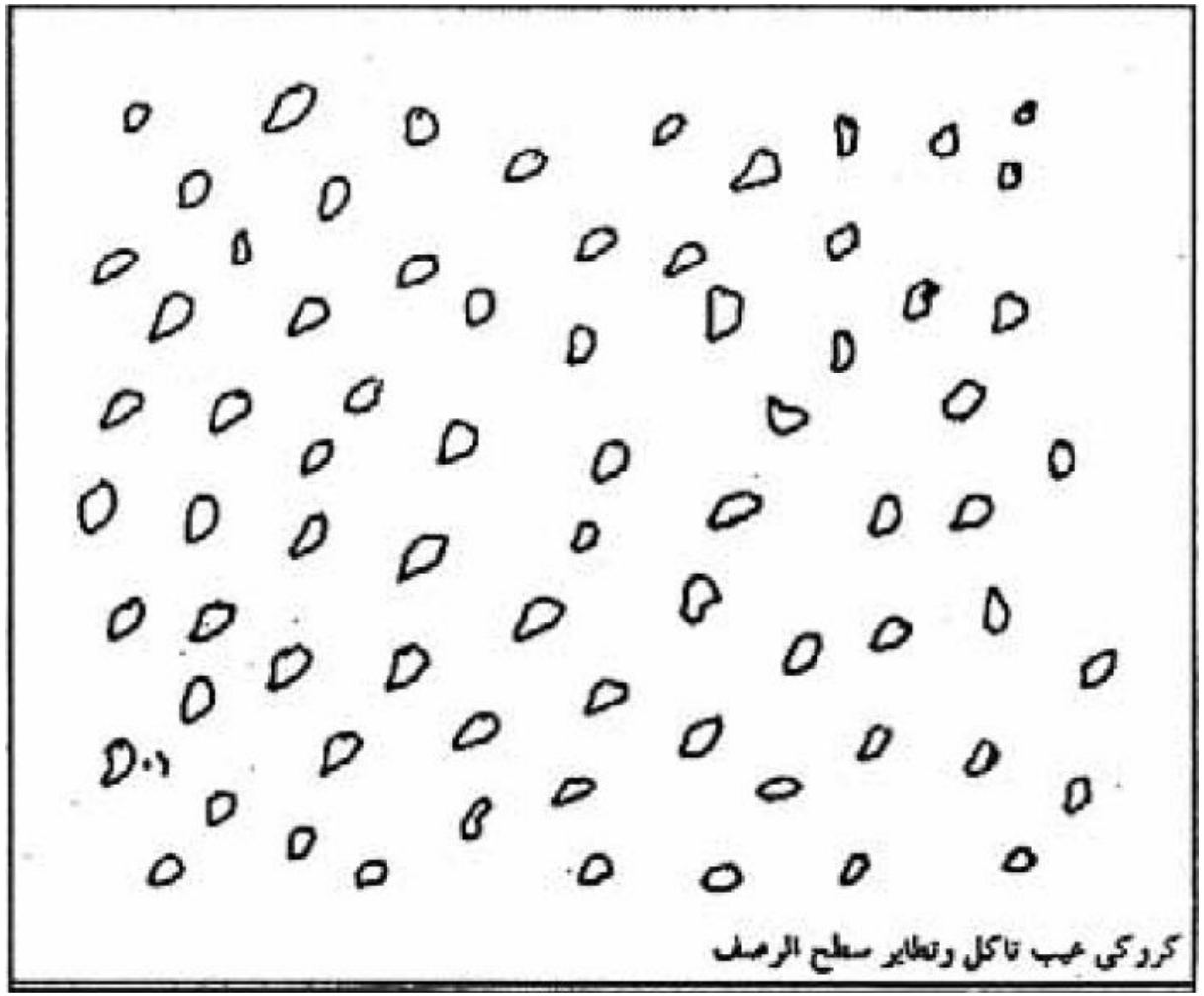
A. Weathering and Raveling

- Weathering and raveling are the wearing away of the pavement surface due to a loss of asphalt or tar binder and dislodged aggregate particles.

These distresses indicate that either the asphalt binder has hardened appreciably or that a poor-quality mixture is present.

- In addition, raveling may be caused by certain types انواع معينةof traffic, for example, tracked vehicles.
- Softening of the surface and dislodging of the aggregates due to oil spillage انسكاب are also included under raveling

Weathering and Raveling Sketch



Weathering and Raveling Severity Levels

L—Aggregate or binder has started to wear away. In some areas, the surface is starting to pit.السطح بدأ بالحفر . In the case of oil spillage, the oil stain can be seen, but the surface is hard and cannot be penetrated with a coin.

M—Aggregate or binder has wear away. The surface texture is moderately rough and pitted. In the case of oil spillage, the surface is soft and can be penetrated with a coin. The pitted diameters are less than 1 cm.

H—Aggregate or binder has been worn away considerably. The surface texture is very rough and severely pitted. The pitted areas are less than 4 in. (100 mm) in diameter and less than 1/2 in. (13 mm) deep; pitted areas larger than this are counted as potholes. In the case of oil spillage, the asphalt binder has lost its binding effect and the aggregate has become loose.

Weathering and Raveling

How to Measure

Weathering and raveling are measured in **square feet or meter** of surface area.

Options for Repair

L—Do nothing; Surface seal; Surface treatment.

M—Surface seal; Surface treatment; Overlay.

H—Surface treatment; Overlay; Recycle; Reconstruct.

Example

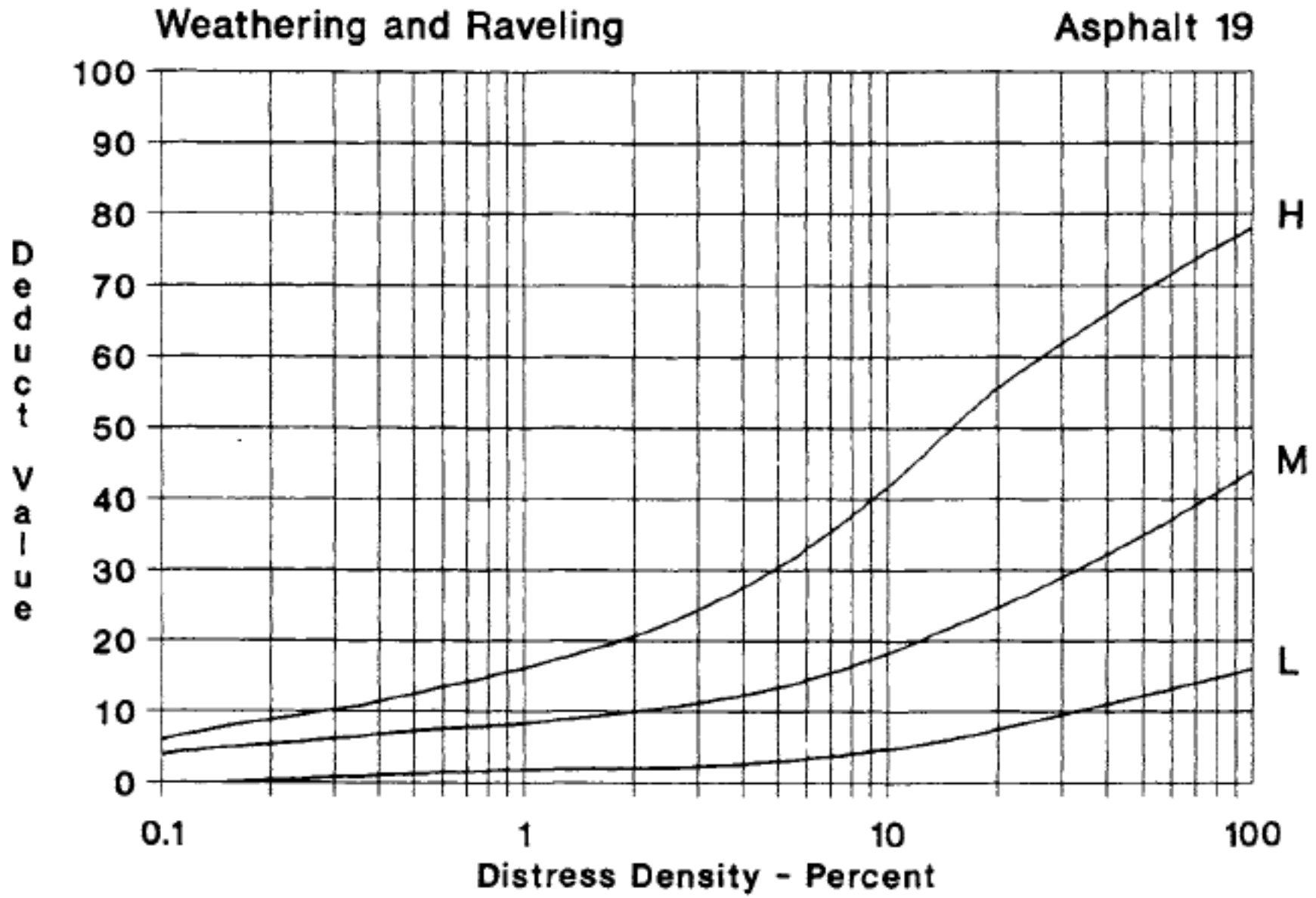
During asphalt pavement inspection of link (100*15) M, from road in Egypt, 15 m^2 high (20% density), 600 m^2 medium, weathering and raveling distress type. Determine deduct value for medium distress.

18

32

50

60


Weathering and Raveling
Asphalt 19
Deduct Value
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.1
1
10
100
Distress Density - Percent

B. Potholes

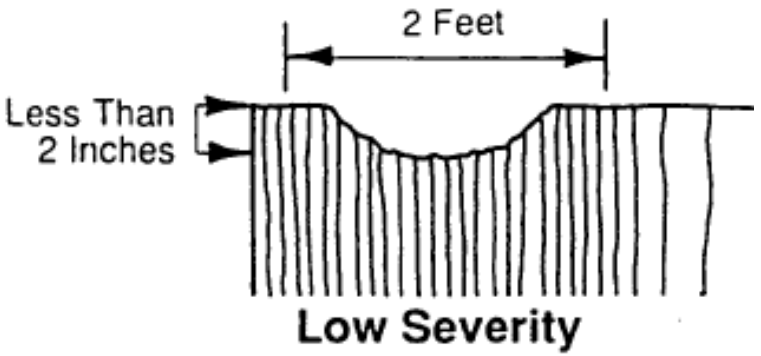
- Potholes are bowl-shaped depressions in the road surface. They are usually <3 ft (<1 m.) in diameter. Potholes are produced when traffic wears away small pieces of the road surface.
- They grow faster when water collects inside the hole. The road then continues to disintegrate because of loosening surface material or weak spots in the underlying soils.
- Weak of asphalt mixtures, Traffic loads, alligator, block cracking.

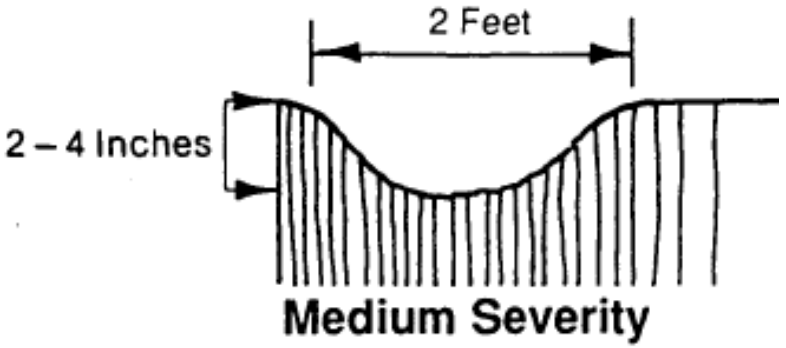
Potholes Severity Levels

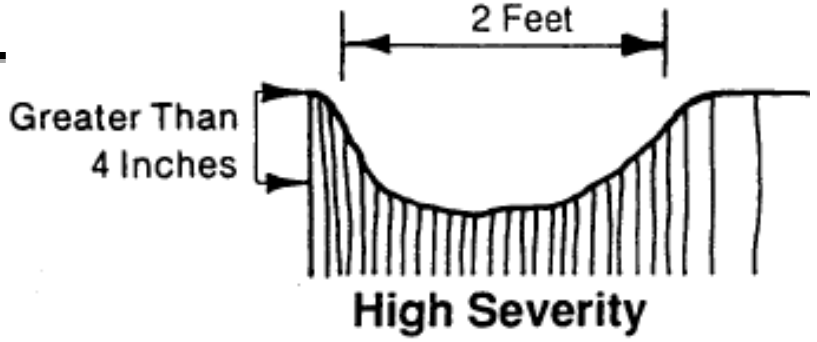
The levels of severity for potholes are based on both the diameter and the depth of the pothole according to the following table

	Average Diameter			
Maximum Depth	Less than 1 ft	1 to 2 ft	2 to 3 ft	More than 3 ft[a]
1/2 to 2 inches	L	L	M	M
2 to 4 inches	L	M	H	H
More than 4 inches	M	H	H	H

[a]If the pothole is over 3 ft in diameter, the area should be determined in square feet and divided by 7 to find the equivalent number of potholes.







Severity Levels

درجة الشدة :

قطر الحفرة / عمق الحفرة	١٠-١٥ سم	١٥-٤٥سم	٤٥-٧٥سم
	الشده		
١ر٢٥ - ٢ر٥ سم	قليل "L"	قليل "L"	متوسط"M"
٢ر٥ - ٥ سم	قليل "L"	متوسط"M"	عالى "H"
أكبر من ٥ سم	متوسط"M"	متوسط"M"	عالى "H"

Potholes

How to Measure

Number of potholes, types.

Potholes are measured by counting the number that are low-, medium- and high-severity in a sample unit and recording them separately by severity level. For example, there may be 14 potholes of medium severity and 8 potholes of low severity.

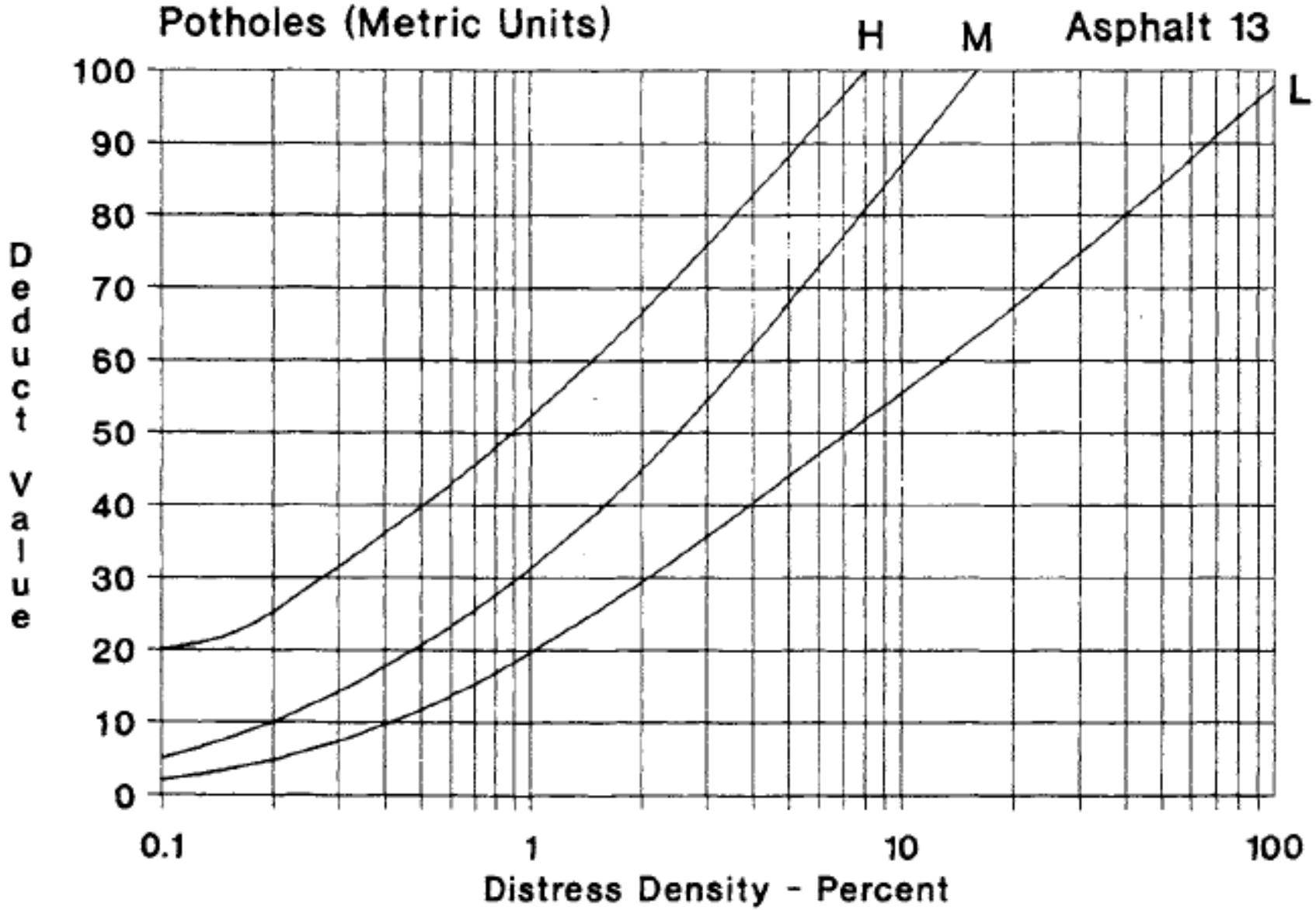
Example

During asphalt pavement inspection of link (100*10) M, from road in Egypt, 200 medium, 400 low, potholes distress type. Determine deduct value for low distress.

180

80

100


Potholes (Metric Units)
H
M
Asphalt 13
L
100
90
80
70
60
50
40
30
20
10
0
Deduct Value
0.1
1
10
100
Distress Density - Percent

C. Patching and Utility Cut Patching

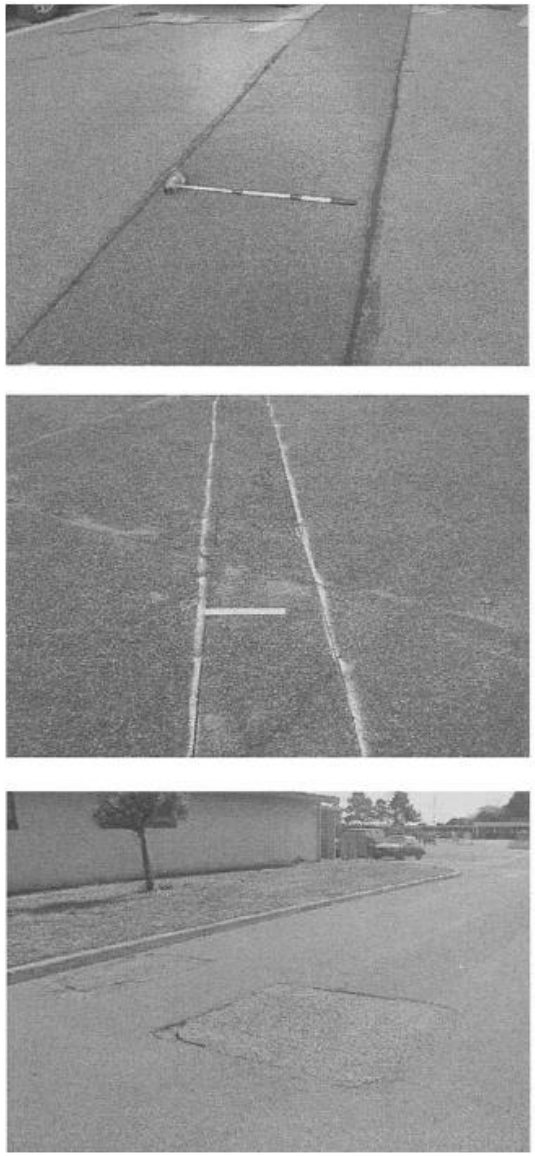
- A patch is an area of pavement that has been replaced with new material to repair the existing pavement. A patch is considered a defect no matter how well it is performing (a patched area or adjacent area usually does not perform as well as an original pavement section). Generally, some roughness is associated with this distress.

Patching and Utility Cut Patching Severity Levels

L—Patch is in good condition and satisfactory. Ride quality is rated as low severity or better.

M—Patch is moderately deteriorated الترقيع هو تدهور معتدلة and/or ride quality is rated as medium severity.

H—Patch is badly deteriorated and/or ride quality is rated as high severity. Needs replacement soon



Patching and Utility Cut Patching

How to Measure

Patching is rated in **square feet or meter** of surface area. However, if a single patch has areas of differing severity, these areas should be measured and recorded separately. For example, a 25 sq ft (2.32 m2) patch may have 10 sq ft (0.9 m2) of medium severity and 15 sq ft (1.35 m2) of low severity. These areas would be recorded separately. No other distresses (e.g., shoving and cracking) are recorded within a patch; even if the patch material is shoving or cracking, the area is rated only as a patch. If a large amount of pavement has been replaced, it should not be recorded as a patch, but considered as new pavement (e.g., replacement of a complete intersection).

Options for Repair

L—Do nothing

M—Do nothing; Replace patch.

H—Replace patch.

Example

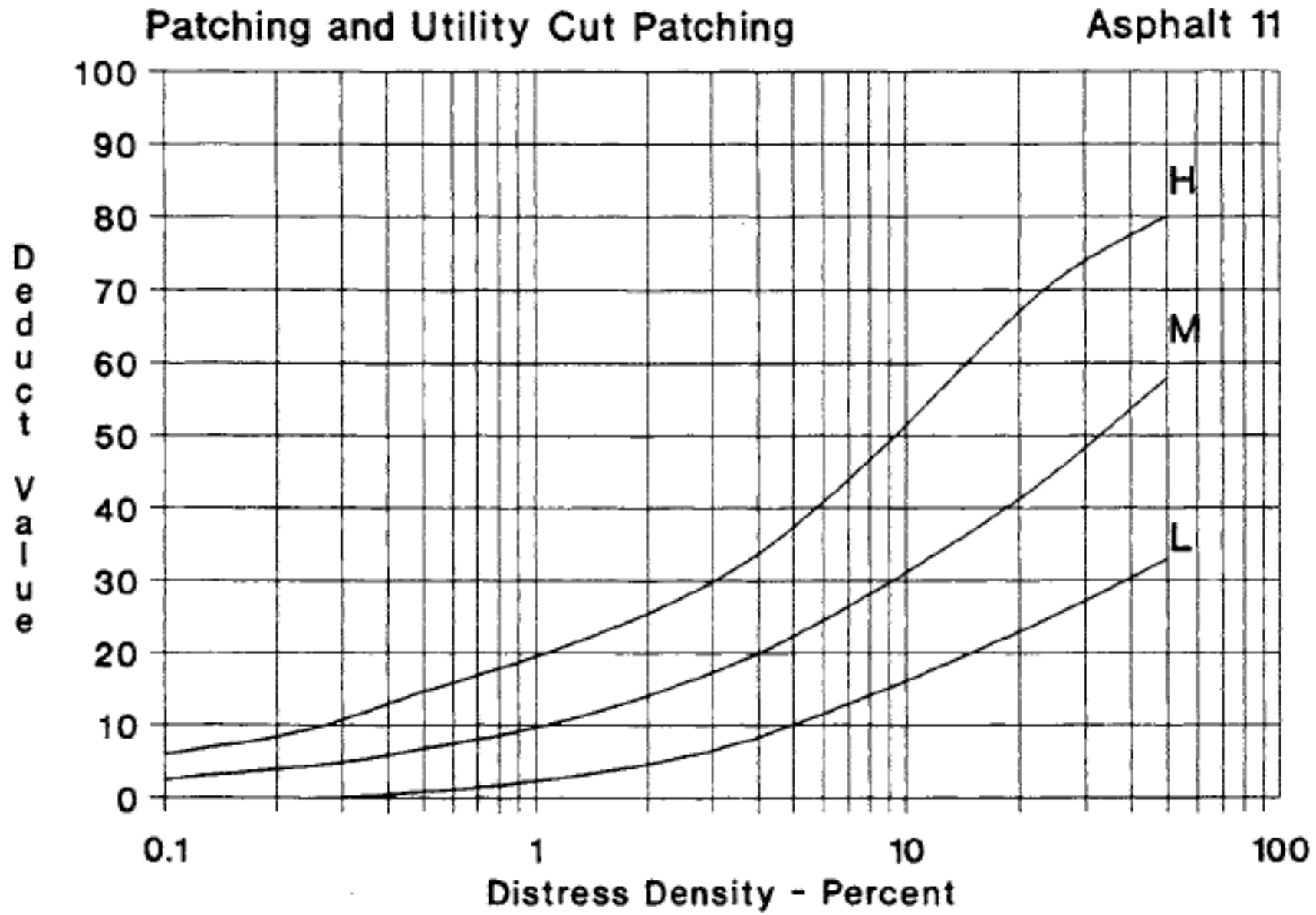
During asphalt pavement inspection of link (100*15) M, from road in Egypt, 15 m^2 high, 600 m^2 medium, Patching and Utility Cut Patching distress type. Determine deduct value for medium distress.

19

54

73

33


Patching and Utility Cut Patching
Asphalt 11
Deduct Value
100
90
80
70
60
50
40
30
20
10
0
H
M
L
0.1
1
10
100
Distress Density - Percent