An analysis of pavement defects

Here is some long-needed help in recognizing the more common types of pavement cracks, along with some indications of probable causes.

With the great strides which have been made in concrete technology and structural design, the problem of pavement cracking is no longer the serious consideration it once was. But nevertheless concrete pavements still develop cracks under certain conditions, and awareness of this fact, coupled with an understanding of the various factors involved, is an essential part of any good concrete man's bag of tricks.

While the subject is admittedly quite complex, and simplification is therefore correspondingly difficult as well as dangerous, it is the purpose of this brief article to show pictorially some of the more common pavement defects and to suggest some plausible explanation for each. Some effort has been made in the selection of photographs to show situations which lend themselves readily to explanation, but it is by no means presumed that the brief analyses presented here are either complete or conclusive.

It is hoped that this presentation may become the nucleus, through the medium of reader participation, of a cumulative pictorial record which will facilitate the instruction of new people in our industry, as well as help to organize the findings and observations of the experienced. With this thought in mind, readers are urged to comment upon and criticize this first attempt, and also to send along similar pictures and information for inclusion in a follow-up article.

For the sake of simplicity the various defects pictured have been arranged in two broad categories: those associated with wheel loads and those not associated with wheel loads. Also, for purposes of this discussion a slab is considered to be the area of pavement between transverse joints in a single traffic lane.

DEFECTS INVOLVING WHEEL LOADS

corner breaks

Figure 1 shows a fairly typical corner break in which the crack runs from the transverse joint of the pavement to the center joint. Where this occurrence is associated with wheel loads the legs on both sides will generally be from 2 to 4 feet long. When the legs on one or both sides are less than 2 feet long, it is likely that the defect is the result of temperature stresses or unequal expansion restraint, such as might result from infiltration or the presence of a plug of concrete in the joint space.

slab end breaks

A typical slab end break, such as that shown in Figure 2, frequently consists of a transverse crack 5 to 8 feet from a joint and ahead of the joint in the direction of traffic. Breaks of this type are usually accompanied by faulting, and they are most often caused by loads applied after there has been a loss of subgrade support as a result of consolidation or pumping action.

slab edge breaks

This type of defect is generally confined to an area within 2 feet of the edge of the slab. It may consist of either a long longitudinal crack or a series of cracks in the form of arcs leaving and returning to the edge of the pavement, as shown in Figure 3.

faulting of slab ends

Faulting, or vertical displacement, at joints and cracks is caused by repetition of wheel loads. It is directly related to the effectiveness of load transference at joints, as well as to the adequacy of subgrade support. This condition will often be noted in combination with slab end breaks (Figure 2), and is frequently accompanied by pumping

pumping

While wheel loads, load repetitions and the accompanying deflections are the immediate causes of pumping (Figure 4), this phenomenon is more immediately related to such factors as surface drainage, the effectiveness with which loads are transferred, and the character of subbase and subgrade soil. Pumping can occur at joints, cracks and edges, and the name is quite descriptive of what actually takes place. The slab, as it deflects under load and then recovers, actually functions as a crude but effective pump to bring a mixture of subsoil and water to the surface.

DEFECTS NOT INVOLVING WHEEL LOADS

plastic shrinkage cracks

Short diagonal cracks in the interior of slabs, such as those shown in Figure 5, are generally plastic shrinkage cracks. They tend to converge toward the center of the slab in the direction of paving. While the surface openings are quite conspic-

Figure 1

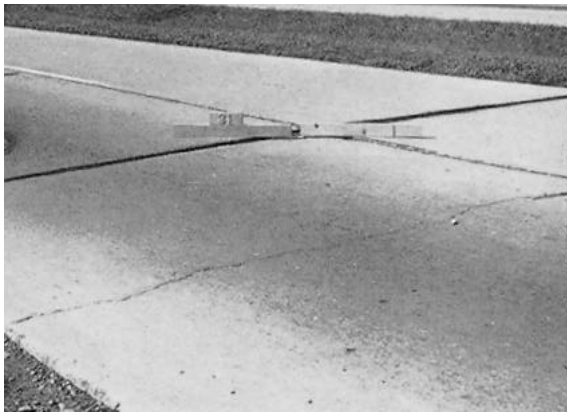

Figure 2

Figure 3

Figure 4

Figure 5

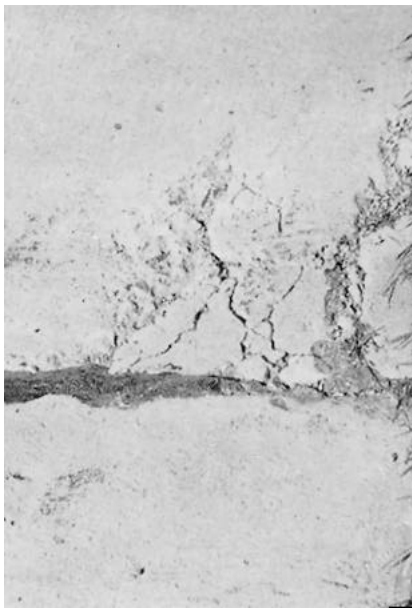

Figure 6

Figure 7

uous, cracks of this type seldom extend very far beneath the surface. Plastic shrinkage cracks form during the early hardening of concrete when wind velocity, low humidity, high air temperature (or all three factors acting together) cause water to evaporate from the concrete surface more rapidly than it is replaced by bleeding.

spalls

The unsightly defects shown in Figures 6 and 7 are what are known as spalls. They are generally quite shallow and almost never do they extend through the depth of the slab. Faulty construction practices are generally responsible for spalling, although poor maintenance, especially failure to keep foreign material from accumulating in

Figure 8

Figure 9

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

joints and cracks, may also be a factor. Edge spalls, especially at the intersections of transverse joints or cracks with longitudinal center joints, are sometimes incorrectly classified as corner breaks. The primary cause in this case is not load but interior restraint stresses.

transverse cracks

Transverse cracks which occur near the center of slabs 40 feet in length are usually simple contraction cracks Figure 8 shows a typical example. When transverse cracks occur within 2 or 3 feet of a joint (Figure 9), and there is no accompanying faulting of the joint, the cause is usually frozen dowels.

longitudinal cracks

Full length longitudinal cracks located within 3 feet of the center joint (Figure 10) may be caused by an ineffective center joint. Similar cracks near the center of a 12-foot traffic lane (Figure 11) are more likely to be caused by serious loss of subgrade support near the edge of the pavement. In this case wheel loads are often a contributing factor.

When there is expansion restraint, near the outside edge of a pavement short longitudinal cracks may tree out from transverse joints (Figure 12). The restraint and the resulting splitting action may be due to the presence of a plug of concrete in the joint space near the edge of the slab. Frozen dowels may also be a factor in this type of cracking.

herringbone cracks

These multiple diagonal cracks are usually caused by heaving of the slab, due to expansive subgrade soils, frost action (Figure 13) or careless mudjacking (Figure 14). Applied loads are not in any way involved in this type of pavement defect.

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