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(Reapproved 2013)

Guide for Design of Jointed Concrete Pavements for Streets and Local Roads

Reported by ACI Committee 325

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This guide provides a perspective on a balanced combination of pavement thickness, drainage, and subbase or subgrade materials to achieve an acceptable pavement system for streets and local roads. Such concrete pavements designed for low volumes of traffic (typically less than 100 trucks per day, one way) have historically provided satisfactory performance when proper support and drainage conditions exist. Recommendations are presented for designing a concrete pavement system for a low volume of traffic and associated joint pattern based upon limiting the stresses in the concrete or, in the case of reinforced slabs, maintaining the cracks in a tightly closed condition. Details for designing the distributed reinforcing steel and the load transfer devices are given, if required.

The thickness design of low-volume concrete pavements is based on the principles developed by the Portland Cement Association and others for analyzing an elastic slab over a dense liquid subgrade, as modified by field observations and extended to include fatigue concepts.

Keywords: dowel; flexural strength; joint; pavement; portland cement; quality control; reinforced concrete; slab-on-grade; slipform; subbase; tie bar; welded wire fabric.

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CHAPTER 1—GENERAL

1.1—Introduction

The design of a concrete pavement system for a low traffic volume extends beyond the process of pavement thickness selection; it entails an understanding of the processes and the factors that affect pavement performance. It also encompasses appropriate slab jointing and construction practices that are consistent with local climatic and soil conditions.

Concrete pavements for city streets and local roads are often used in residential areas and business districts, and in rural areas to provide farm-to-market access for the movement of agricultural products. The term "low volume" refers to pavements subject to either heavy loads but few vehicles, or light loads and many vehicles. City streets and local roads also serve an aesthetic function because they are integrated into the landscape and architecture of a neighborhood or business district.

Concrete pavement performs well for city street and local road applications because of its durability while being continuously subjected to traffic and, in some cases, severe climatic conditions. Because of its relatively high stiffness, concrete pavements spread the imposed loads over large areas of the subgrade and are capable of resisting deformation caused by passing vehicles. Concrete pavements exhibit high wear resistance and can be easily cleaned if necessary. Traffic lane markings can be incorporated into the jointing pattern where the concrete's light-reflective surface improves visibility. Concrete pavement surfaces drain well on relatively flat slopes.

The major variables likely to affect the performance of a well-designed concrete pavement system for city streets and local roads are traffic, drainage, environment, construction, and maintenance. Each of these factors may act separately or interact with others to cause deterioration of the pavement. Due to the nature of traffic on city streets and local roads, the effects of environment, construction, and maintenance can play more significant roles in the performance than traffic. Nonetheless, complete information may not be available regarding certain load categories that make up the mixture of traffic carried on a given city street or local road.

1.2—Scope

This guide covers the design of jointed plain concrete pavements (JPCP) for use on city streets and local roads (driveways, alleyways, and residential roads) that carry low volumes of traffic. This document is intended to be used in conjunction with ACI 325.9R. References are provided on design procedures and computer programs that consider design in greater detail. This guide emphasizes the aspects of concrete pavement technology that are different from procedures used for design of other facilities such as highways or airports.

1.3—Background

The thickness of concrete pavement is generally designed to limit tensile stresses produced within the slab by vehicle loading, and temperature and moisture changes within the slab. Model studies and full-scale, accelerated traffic tests have shown that maximum tensile stresses in concrete pavements occur when vehicle wheel loads are close to a free or unsupported edge in the midpanel area of the pavement. Stresses resulting from wheel loadings applied near interior longitudinal or transverse joints are lower, even when good load transfer is provided by the joints. Therefore, the critical stress condition occurs when a wheel load is applied near the pavement's midslab edge. At this location, integral curbs or thickened edge sections can be used to decrease the design stress. Thermal expansion and contraction, and warping and curling caused by moisture and temperature differentials within the pavement can cause a stress increase that may not have been accounted for in the thickness design procedure. The point of crack initiation often indicates whether unexpected pavement cracking is fatigue-induced or environmentally induced due to curling and warping behavior. Proper jointing practice, discussed in Chapter 4, reduces these stresses to acceptable levels.

Concrete pavement design focuses on limiting tensile stresses by properly selecting the characteristics of the concrete slab. The rigidity of concrete enables it to distribute loads over relatively large areas of support. For adequately designed pavements, the deflections under load are small and the pressures transmitted to the subgrade are not excessive. Although not a common practice, high-strength concrete can be used as an acceptable option to increase performance.

Because the load on the pavement is carried primarily by the concrete slab, the strength of the underlying material (subbase) has a relatively small effect on the slab thickness needed to adequately carry the design traffic. Subbase layers do not contribute significantly to the load-carrying capacity of the pavement. A subbase, besides providing uniform support,