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Guide for the Design and Construction of Concrete Site Paving for Industrial and Trucking Facilities

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This guide provides information useful in the design and construction of a successful site-paving project for heavy-duty industrial and trucking facilities. This information assists architects/engineers, contractors, and testing agencies with designing, detailing, constructing, repairing, and inspecting site paving. Engineers use this guide to make recommendations for the pavement support system, concrete mixture, pavement thickness, joint spacing, and load transfer devices. Thickness design tables are including for common over-the-road trucks and industrial lift trucks. Tables are also provided to check the pavement thickness for punching shear and concrete strength for bearing stress applied by loaded trailers that have been disconnected from the tractor. Contractors use this guide to understand proper ways to construct site paving with block or strip placements and avoid common mistakes made during construction. Proper placing, consolidating, and finishing techniques are described to construct a durable pavement that complies with the project documents. Inspectors and testing agencies use this guide to understand the design and be better equipped to monitor the project from stripping and grubbing of the site to concrete pavement curing. Testing and inspection included in this guide should only be done by individuals holding the appropriate certifications.

Keywords: industrial pavement; joint stability; lift truck; lug anchor; over-the-road truck; pavement support system; sustainable industrial pavement system; unreinforced concrete pavement.

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CHAPTER 1—GENERAL

1.1—Introduction

Concrete provides a strong and durable surface for vehicle maneuvering and storage areas, making it especially suited for site paving at industrial and trucking facilities. Concrete site paving for industrial and trucking facilities has many similarities to other types of concrete pavements, such as typical concrete parking lots, streets, and highways. Service distinctions may include traffic speed and zones dedicated specifically to multi-directional or channelized traffic flow. These facilities are often constructed to serve not only over-the-road trucks, but industrial lift trucks, such as those imposed by dolly wheels and trailer pads, tracked vehicles, other nontraditional vehicles, and other vehicular-related static loads such as trailers dropped on-site between loading and off-loading. Industrial and trucking facilities have paved areas that are generally larger in size than most parking lots. The scale of these projects and the comparatively high traffic count and special loads generally justify more attention to design than typical parking lots. These distinctions along with changing technologies initiated the development of this guide.

Note that ACI 330R can be used as a resource for some similarly-described facilities. Each document has been developed as a stand-alone guide that provides critical design information and recommended construction practices for successful paving projects. Guide selection to a specific project should consider the specific traffic level to be accommodated as well as the design load types, espe-

cially if they include industrial lift trucks and other special loads, the percentage of accommodated vehicles (which are very heavy), site geotechnical considerations such as in-place subgrade character and drainage, joint spacing, and potential future uses of the facility. In general, this guide is intended for facilities with heavier design loads, nonstandard vehicles, higher volumes of heavy trucks, or both. Examples of such facilities include warehouses, factories, truck terminals, heavy equipment sales and service distribution centers, and ports. ACI 330R is intended for use when truck loads are generally lighter, traffic volumes lower, or both, though many successful projects accommodating higher average daily truck traffic of mixed vehicle loads have been designed using ACI 330R. Examples of typical parking lots most consistent with the intended scope of ACI 330R would include concrete pavements for apartment complexes, shopping malls, convenience stores, gas stations, banks, and office buildings.

Concrete offers many advantages over asphalt for pavements at industrial or trucking facilities. Concrete provides greater surface and pavement system durability and favorable economics with respect to life-cycle costs, and sometimes even with initial construction costs. Facility night-time illumination can be provided at a lower cost with concrete due to concrete surface reflectance. Concrete also reduces traffic load stresses imposed on subbase and subgrade soils and can be constructed with a wide variety of construction equipment, ranging from hand tools and vibratory screeds, to laser-guided screeds and large highway paving equipment. The sustainable construction benefits of concrete are also an important consideration in pavement type selection (Chapter 9).

The paired values stated in inch-pound and SI units are usually not exact equivalents. Therefore, each system is to be used independently of the other. Combining values from the two systems could result in nonconformance with this guide.

1.2—Scope

This guide is based on the current knowledge and practices for the design, construction, and maintenance of concrete site pavements for industrial and trucking facilities, emphasizing the aspects of concrete pavement technology that are different from procedures used to design and construct floor slabs, parking lots, streets, and highways. This guide is neither a standard nor a specification, and it is not intended to be included by reference in construction contract documents.

Pavements for industrial and trucking facilities are designed similarly to parking lots, streets, and highways, but with a few key technical differences. Site pavements have most loads imposed on interior panels surrounded by other pavement, which provide varying degrees of panel edge support or load transfer on all sides. Other pavement applications may carry loads along and across relatively unsupported edges, where greater deflections and stresses are not a significant concern due to lighter design traffic. Streets and highways are commonly designed to drain toward an edge where storm water can be carried away from the pavement. Site pavements are commonly designed so a portion of the storm water is collected internally and conveyed away through underground systems. Site pavements often accommodate appurtenances, such as drainage structures, lighting standards, bollards, and fuel islands. Provisions for these appurtenances should be considered in the design, layout, and construction of the crack-control (jointing) system.

1.3—Background

Design practices for concrete site pavements have often varied by local experiences and are based on guidance derived from a combination of design references covering heavy pavements and floor slabs. The unique demands of these types of facilities have made it challenging for project designers to integrate all appropriate design protocols and consider all performance influences. This document is intended to respond to the need for a single, source guide on concrete site paving for industrial and trucking facilities.

Concrete pavement thickness is one of the critical design elements for industrial and trucking facility site paving applications, just as it is for parking lots and other mixed-vehicle pavements. This is true not only for engineering economy but also for the pavement structure to reliably carry loads from nontraditional vehicles and certain static loads. For concrete site paving, proper thickness design should minimize pavement stresses and deflections along joints and pavement edges. Many types of geotechnical site conditions that can successfully accommodate light traffic pavements are not appropriate for industrial and trucking facility site pavements without enhancement of the subgrade system, inclusion of one or more subbases, or both. This type of distinction also extends to load transfer considerations.

Subgrade improvement, joint spacing and layout, and load transfer strategies are important elements of industrial and trucking site pavement design. Thickness should reflect these considerations along with pavement stress levels for all envisioned loadings. Construction planning should consider surface durability needs and appropriate tolerances.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

B_n = nominal bearing strength
B_u = factored bearing load
E_C = modulus of elasticity
k-value = modulus of subgrade reaction
M_R = resilient modulus
M_R = resilient modulus
V_n = nominal shear strength
V_u = factored shear force

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource, “ACI Concrete Terminology,” https://www.concrete.org/store/productdetail.aspx?ItemID=CT13. Definitions provided herein complement that source.

distributed steel reinforcement—welded-wire fabric or bar mats used in pavement to hold concrete together across