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Guide to Design of Slabs-on-Ground

Reported by ACI Committee 360

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This guide presents information on the design of slabs-on-ground, primarily industrial floors. It addresses the planning, design, and detailing of slabs. Background information on design theories is followed by discussion of the types of slabs, soil-support systems, loadings, and jointing. Design methods are given for unreinforced concrete, reinforced concrete, shrinkage-compensating concrete, post-tensioned concrete, fiber-reinforced concrete slabs-on-ground, and slabs-on-ground in refrigerated buildings, followed by information on shrinkage and curling. Advantages and disadvantages of these slab design methods are provided, including the ability of some slab designs to minimize cracking and curling more than others. Even with the best slab designs and proper construction, it is unrealistic to expect crack-free and curl-free floors. Every owner should be advised by the designer and contractor that it is normal to expect some cracking and curling on every project. This does not necessarily reflect adversely on the adequacy of the floor's design or quality of construction. Design examples are given.

Keywords: curling; design; floors-on-ground; grade floors; industrial floors; joints; load types; post-tensioned concrete; reinforcement (steel, fibers); shrinkage; shrinkage-compensating; slabs; slabs-on-ground; soil mechanics; warping.

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CHAPTER 1—INTRODUCTION

1.1—Purpose and scope

This guide presents information on the design of slabs-on-ground. Design is the decision-making process of planning, sizing, detailing, and developing specifications preceding construction of slabs-on-ground. Information on other aspects, such as materials, construction methods, placement of concrete, and finishing techniques is included only where needed in making design decisions.

In the context of this guide, slab-on-ground is defined as: a slab, supported by ground, whose main purpose is to support the applied loads by bearing on the ground. The slab is of uniform or variable thickness and it may include stiffening elements such as ribs or beams. The slab may be unreinforced or reinforced with nonprestressed reinforcement, fibers, or post-tensioned tendons. The reinforcement may be provided to limit crack widths resulting from shrinkage and temperature restraint and the applied loads. Post-tensioning tendons may be provided to minimize cracking due to shrinkage and temperature restraint, resist the applied loads, and accommodate movements due to expansive soil volume changes.

This guide covers the design of slabs-on-ground for loads from material stored directly on the slab, storage rack loads, and static and dynamic loads associated with equipment and vehicles. Other loads, such as roof loads transferred through dual-purpose rack systems, are also mentioned.

This guide discusses soil-support systems, shrinkage and temperature effects; cracking, curling or warping; and other concerns affecting slab design. Although the same general principles are applicable, this guide does not specifically address the design of roadway pavements, airport pavements, parking lots, or mat foundations.

1.2—Work of ACI Committee 360 and other relevant committees

There are several ACI committees listed below that provide relevant information concerning slabs-on-ground design and construction or similar slab types that are not addressed in this guide such as pavements, parking lots, or mat foundations. These committees provide documents where more detailed information for topics discussed in this guide can be found.

1.2.1 ACI Committee 117 develops and reports information on tolerances for concrete construction through liaison with other ACI committees.

1.2.2 ACI Committee 223 develops recommendations on the use of shrinkage-compensating concrete.

1.2.3 ACI Committee 301 develops and maintains specifications for concrete construction.

1.2.4 ACI Committee 302 develops and reports information on materials and procedures for the construction of concrete floors. ACI 302.1R provides guidelines and recommendations on materials and slab construction. ACI 302.2R provides guidelines for concrete slabs that receive moisture-sensitive flooring materials.

1.2.5 ACI Committee 318 develops and maintains building code requirements for structural concrete.

1.2.6 ACI Committee 325 develops and reports information on concrete pavements.

1.2.7 ACI Committee 330 develops and reports information on concrete parking lots and paving sites. Parking lots and paving sites have unique considerations that are covered in ACI 330R.

1.2.8 ACI Committee 332 develops and reports information on concrete in residential construction.

1.2.9 ACI Committee 336 develops and reports information on footings, mats, and drilled piers. The design procedures for combined footings and mat foundations are given in ACI 336.2R. Mat foundations are typically more rigid and more heavily reinforced than common slabs-on-ground.

1.2.10 ACI Committee 360 develops and reports information on the design of slabs-on-ground, with the exception of highways, parking lots, airport pavements, and mat foundations.

1.2.11 ACI Committee 544 develops and reports information on concrete reinforced with short, discontinuous, randomly-dispersed fibers. ACI 544.3R is a guide for specifying, proportioning, and production of fiber-reinforced concrete (FRC).

1.3—Work of non-ACI organizations

Numerous contributions of slabs-on-ground design and construction information used in this guide come from organizations and individuals outside the American Concrete Institute. The U.S. Army Corps of Engineers (USACE), the National Academy of Science, and the Department of Housing and Urban Development (HUD) have developed guidelines for floor slab design and construction. The Portland Cement Association (PCA), Wire Reinforcement Institute (WRI), Concrete Reinforcing Steel Institute (CRSI), Post-Tensioning Institute (PTI), as well as several universities and consulting engineers have studied slabs-on-ground and developed recommendations for their design and construction. In addition, periodicals such as *Concrete International* and *Concrete Construction* have continuously disseminated information about slabs-on-ground.

1.4—Design theories for slabs-on-ground

1.4.1 *Introduction*—Stresses in slabs-on-ground result from applied loads and volume changes of the soil and concrete. The magnitude of these stresses depends on factors such as the degree of slab continuity, subgrade strength and