Stages-of-Hydration Charts

Chapter 4 contains several variations of stages-of-hydration charts (figure 3). These charts, based on a general time-heat curve, illustrate changes in heat generated by hydration during concrete's first hours and days. Accompanying text explains chemical changes during hydration and their effect on concrete properties, which are roughly represented by the time-heat curve. The changes are grouped according to five stages of hydration.

Variations of the chart illustrate and describe the effect of various materials, construction practices, and other variables on hydration. The IMCP manual, however, is not a chemistry book; even the most detailed sections of chapter 4 and the accompanying illustrations of hydrating cement provide only an overview of hydration based on general concepts.

Early-Age Cracking References

Chapter 5 (concrete properties) ends with a discussion of early-age cracking. Although not a property of concrete, early-age cracking can be related to several properties. The final pages of chapter 5 are specially formatted, one- and two-page descriptions of various early-age cracks. These pages could be good stand-alone references.

Suite of Q/C Tests

Chapter 9 on quality control ends with one- or two-page descriptions of various quality control tests. They follow the same structure: Why do this test? What is the theory behind it? In general, how is it run? What equipment do you need? How do you interpret the results? etc. These descriptions do not substitute for formal testing methods. They just give readers a quick understanding of why and when particular tests are conducted.

Troubleshooting Tables

All of chapter 10 is a set of tables organized by the time at which various problems may occur with the mix or slab. For every potential problem, there is a list of possible causes, potential actions, and references to pages in the manual that give more information about the phenomena described. Again, these troubleshooting pages could be a good stand-alone reference.

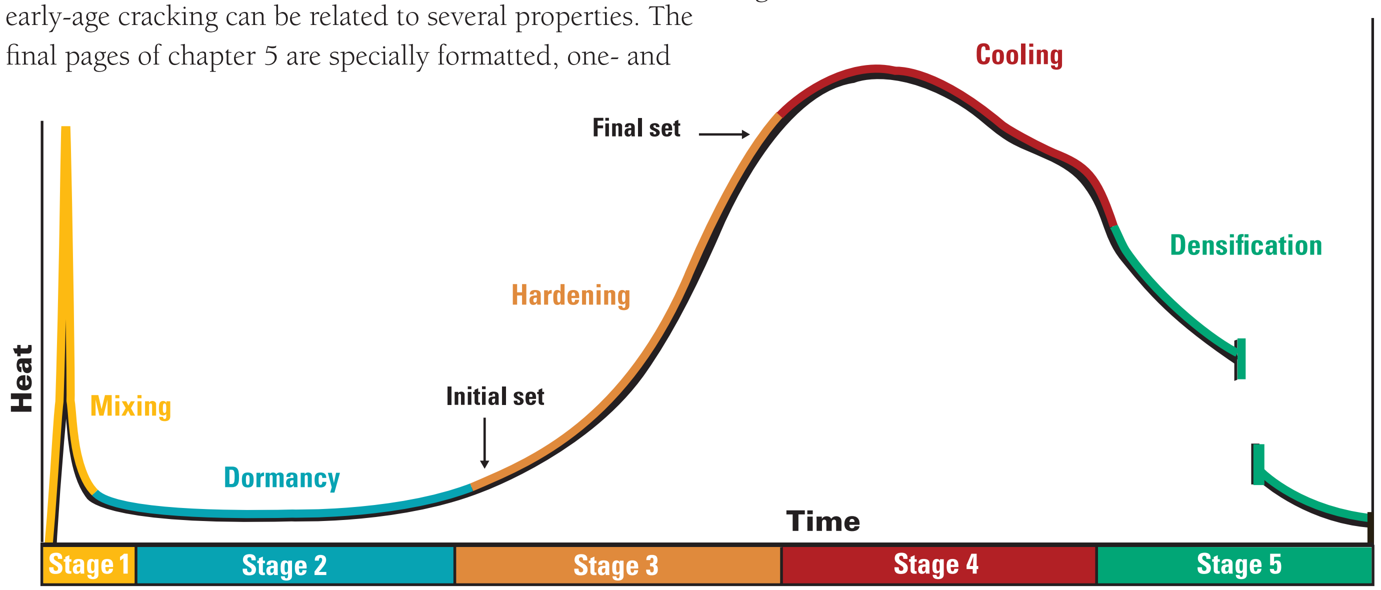

Figure 3. The five stages of hydration mapped on a heat vs. time curve

National Concrete Pavement Technology Center

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This technical summary is based on chapter 1 of the IMCP Manual (Taylor, P.C., et al. 2006. *Integrated Materials and Construction Practices for Concrete Pavement: A State-of-the-Practice Manual*, Ames, Iowa, Iowa State University [FHWA HIF-07-004] [www.cptechcenter.org/publications/imcp/]) and was sponsored by the Federal Highway Administration. (References for any citations in this summary are at the end of the chapter.)

CP Tech Center Mission

The mission of the National Concrete Pavement Technology Center is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

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A summary of chapter 1 (pages 1–5) of the *IMCP Manual* (reference information on page 4)

Introduction to the IMCP Manual

This document is one of a set of technical summaries of chapters 1 through 10 of the *Integrated Materials and Construction Practices for Concrete Pavements: A State-of-the-Practice Manual* (IMCP manual). Together, these summaries provide a general overview of information in the manual and introduce its important concepts. To be useful as training documents, the technical summaries should be used in conjunction with the manual.

This document briefly summarizes chapter 1. It describes why the IMCP manual was developed, the kind of information it contains, and how the material is organized. Anyone planning to study the IMCP manual or attend a related workshop will benefit from reviewing chapter 1 and/or this technical summary.

Purpose of the Manual

In general, the IMCP manual is an offshoot product of a pooled-fund study, Materials and Construction Optimization for Prevention of Premature Pavement Distress (or the MCO project) (TPF-5[066]). In that study, 17 States identified a suite of tests for optimizing concrete materials and mixes. The States discovered that they have different gaps in knowledge and practice. So, FHWA funded development of a one-source reference manual that describes best practices—how and why—to optimize materials and mixes.

The goal of the IMCP manual is to help readers understand how the materials in concrete interact and how that understanding can help personnel optimize concrete's performance at every stage of a paving project (figure 1). The intended audience is public and private personnel with various roles in concrete pavement projects: design engineers, quality assurance technicians, construction contractors (managers and field supervisors), materials engineers, materials suppliers, etc.

The IMCP manual is not a full-blown concrete pavement design or construction course. It does not contain any information about maintenance and rehabilitation.

The content of the IMCP manual reflects the technical expertise of about 60 authors and reviewers from around the country. An oversight committee of 15 experts then provided advice and input to the development of a related workshop.

Chapter Topics

Chapter 2 of the IMCP manual discusses concepts of pavement design that are most important for optimizing concrete performance. It addresses pavement design types, structural and functional performance issues, concrete properties that are critical to its performance (these will

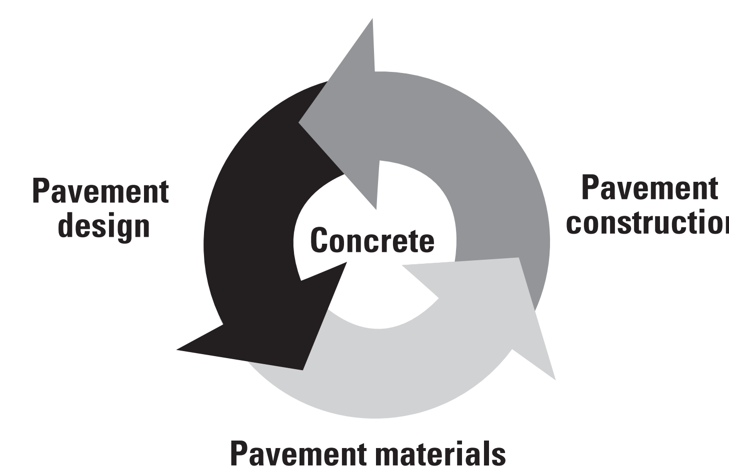

Figure 1. The IMCP manual helps personnel at every stage of a paving project optimize the concrete's ultimate performance.

be covered thoroughly in chapter 5), site factors that affect concrete design, and construction issues that have to be taken into account. It also briefly describes overlay design considerations.

Every concrete mixture contains cements, water, and fine and course aggregates. Today, we also use many different kinds of supplementary cementitious materials and chemical admixtures. Chapter 3 describes all these materials in detail. It is a long chapter because this information is central to optimizing concrete performance.

Hydration, a chemical reaction between cement and water, is described in chapter 4. Ultimately, the products of hydration hold all the mix materials together in a durable concrete slab. Everyone in the concrete pavement business should understand at least the basics of hydration, so chapter 4 tells the story of hydration three times: first very simply, then with more details and illustrations, and then with more information about the chemistry involved. This third version includes information about materials incompatibilities. If you don't know anything about hydration, the repetition can help you understand it. Or, you can read the simplest description and skip the detailed sections if you prefer.

One of the elements of pavement design (chapter 2) is determining what properties we want the concrete to have for a particular project. Chapter 5 outlines all the properties of fresh and hardened concrete and their effects on concrete performance. The information in chapters 3 and 4 will help you understand chapter 5.

By the time you get to chapter 6, you will at least generally understand the materials in the mix and how they react together, as well as the various concrete properties. Chapter 6 describes a general approach to mix design and proportioning: selecting and combining available materials to get the desired properties for a particular project.

Chapter 7 describes the aspects of subgrade preparation and drainage that are critical for optimizing the concrete slab. Chapter 8 describes stockpile management, batching, placement, finishing, jointing, making field adjustments, protecting the new concrete, and adapting construction practices to the weather. Chapters 7 and 8 are relatively short; they focus only on the aspects of pre-construction and construction that are important for optimizing the concrete slab.

Chapter 9 describes why testing is important—before, during, and soon after construction—and offers a suite of tests that will help you monitor quality control from day one.

This chapter can be a quick reference, but it is most helpful if you have a fairly good understanding of the preceding chapters.

Sometimes, even with good pavement design, materials selection, mix design, and construction practices, things can go wrong. The final chapter 10 will help you recognize and fix problems before they become serious.

Navigational Tools

Of course, you know how to find your way around a book. Chapter 1, however, includes brief description of navigational helps designed in the layout of the manual (figure 2).

Thumb Index

On the outer edge of all pages is a colored thumb index. It will help you flip from chapter to chapter. This is a big manual, and the thumb index can be especially useful when you are looking up a cross-reference.

Cross-References

Because all the stages of a concrete project are affected by the others, the manual cannot simply describe one stage in a chapter and be done with it. So, every chapter cross-references related information in previous and later chapters.

Subject Index

If you want to know about a specific topic from the point of view of each of the chapters, use the subject index at the end of the manual. Again, the thumb index can help you flip quickly through the manual to check these references.

Special Formatting

Some of the information in the book is formatted differently to make it more useful.

Key Points

The first page of every chapter lists the main sections in that chapter. Every main section begins with a list of key points in that section. Following the key points, the text becomes more detailed. So, you can read as little or as much detail as you want about each subject.

Sidebars

Information is presented in sidebars for different reasons. Sometimes they highlight information that is useful but does not necessarily fit into the flow of the chapter. Sometimes they repeat and emphasize an important idea from the text. Sometimes they tell a story that helps explain information in the text.

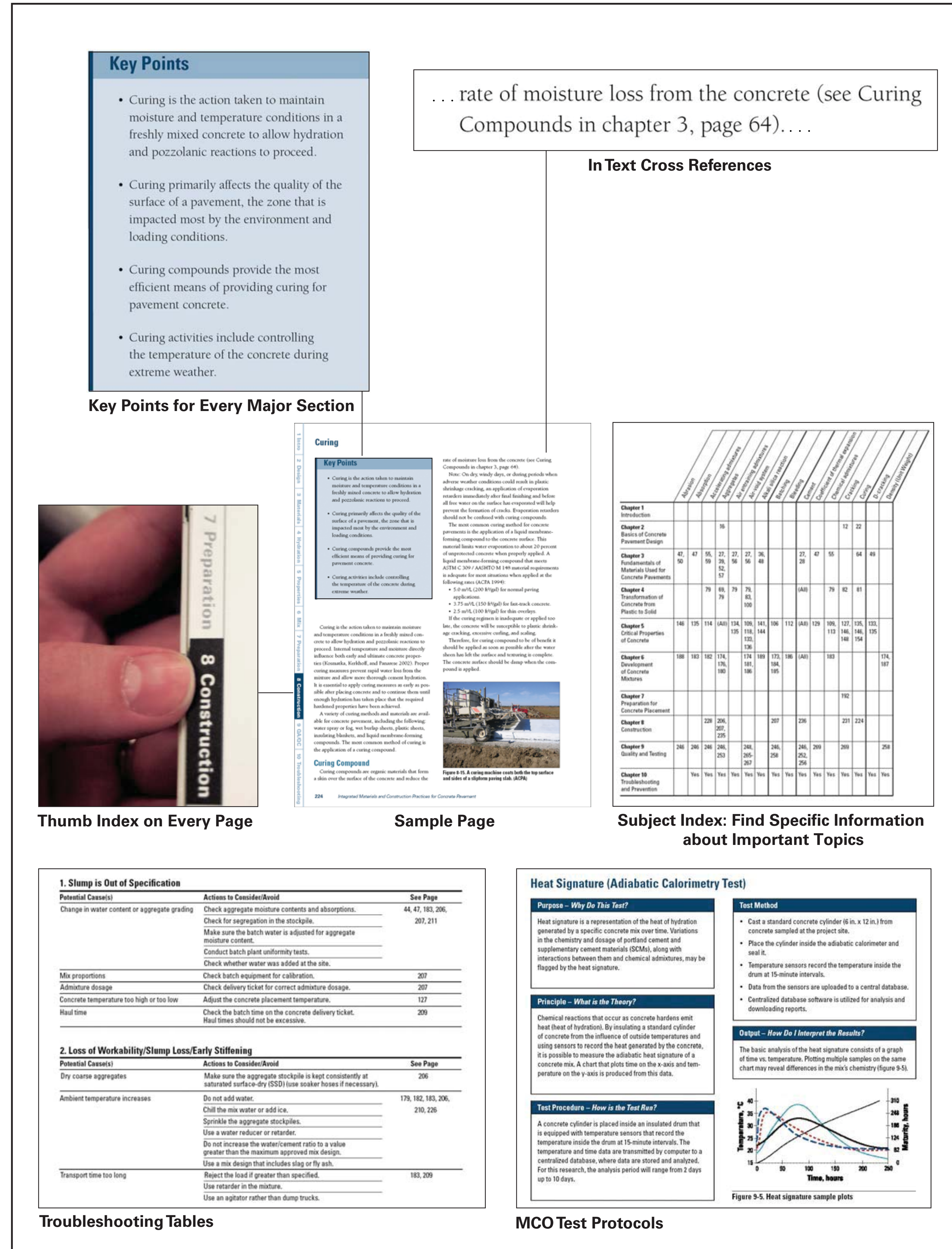

Figure 2. Several navigational tools and specially formatted pages can help readers find information.