

**Don A. Watson**

**CONSTRUCTION  
MATERIALS  
AND  
PROCESSES**

**second edition**



# CONSTRUCTION MATERIALS AND PROCESSES

Second Edition

**Don A. Watson, A.I.A., F.C.S.I.**  
Architect, Consultant

**Gregg Division  
McGraw-Hill Book Company**

New York	Mexico
St. Louis	Montreal
Dallas	New Delhi
San Francisco	Panama
Auckland	Paris
Bogotá	São Paulo
Düsseldorf	Singapore
Johannesburg	Sydney
London	Tokyo
Madrid	Toronto

## Library of Congress Cataloging in Publication Data

Watson, Donald Arthur, [date]  
Construction materials and processes.

Includes bibliographies and index.

1. Building materials. 2. Building. I. Title.  
TA403.W34 1978 691 77-612  
ISBN 0-07-068471-5

## CONSTRUCTION MATERIALS AND PROCESSES

Copyright © 1978 by McGraw-Hill, Inc. All rights reserved. Printed in the United States of America. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

1 2 3 4 5 6 7 8 9 0 W C W C 7 8 3 2 1 0 9 8 7

The editors for this book were William K. Fallon and Susan L. Schwartz, the designer was Tracy A. Glasner, the art supervisor was George T. Resch, and the production supervisor was Regina R. Malone. It was set in Plantin by Holmes Composition Service.  
Printed and bound by Webcrafters, Inc.



# Contents

<b>PREFACE</b>	1	<b>Division 4 MASONRY</b>	72
<b>Division 1 GENERAL REQUIREMENTS</b>	2	Mortar	
Materials Evaluation		Brick	
References		Manufacture of Brick	
Trade Associations		Brickwork	
Construction Specifications Institute		Structural Clay Tile	
Reference Standards		Concrete Block	
Testing Laboratories		Bonded Walls	
Mettrication		Masonry Panels	
Questions		Wall-bearing Construction	
References for Further Study		Gypsum Block	
		Glass Block	
		Stone	
<b>Division 2 SITE WORK</b>	18	Stone Masonry	
Soil Classification		Questions	
Soil Behavior		References for Further Study	
Soil Investigation			
Soil Modification		<b>Division 5 METALS</b>	100
Foundations and Piles		Classification of Metals	
Paving and Surfacing Materials		Iron	
Questions		Cast Iron	
References for Further Study		Wrought Iron	
		Steel	
		Shaping Steel	
<b>Division 3 CONCRETE</b>	44	Steel Pipe, Tubing, and Wire	
Materials in Concrete		Steel Castings	
Cement		Classification of Steels	
Aggregate		Steel Construction	
Admixtures		Fire-protective Methods for Exposed Steel	
Water		Steel Fasteners	
Strength of Concrete		Steel Floor and Roof Framing	
Design of Mix		Aluminum and Aluminum Alloys	
Mixing of Concrete		Aluminum Products	
Placing Concrete		Lead	
Construction Joints		Zinc and Zinc Coatings	
Finishing and Curing Concrete		Copper and Copper Alloys	
Reinforced Concrete		Nickel, Chromium, Cadmium, and Titanium	
Precast Concrete		Combined Metals	
Prestressed Concrete		Galvanic Action	
Questions		Questions	
References for Further Study		References for Further Study	



<b>Division 6 CARPENTRY</b>	142	<b>Division 9 FINISHES</b>	274
Characteristics of Wood		Plaster	
Defects in Wood		Portland Cement Plasters	
Preparation of Lumber		Lath	
Characteristics of Softwoods and Hardwoods		Lath-and-Plaster Construction	
Lumber Grades		Drywall Systems	
Treated Lumber		Ceramic Tile	
Glued-Laminated Timber		Tilesetting	
Plywood		Terrazzo	
Pressed Boards		Acoustics	
Wood Fasteners		Acoustical Materials	
Plastics		Wood Flooring	
Forming Methods		Resilient Flooring	
Foamed Plastics		Carpeting	
Fiber Glass Reinforced Plastics		Paint	
Plastic Laminates		Pigments	
Questions		Vehicles	
References for Further Study		Solvents	
<b>Division 7 THERMAL AND MOISTURE PROTECTION</b>	180	Clear Coatings and Stains	
Dampproofing and Waterproofing		Primers and Sealers	
Thermal Insulation		Special-Purpose Paints	
Roofing Materials		Wall Coverings	
Shingles, Tiles, and Slate		Questions	
Wood Shingles and Shakes		References for Further Study	
Membrane Roofing		<b>Division 10 SPECIALTIES</b>	332
Metal Roofing		Chalkboards and Tackboards	
Weatherproofing and Drainage		Toilet Compartments	
Sealants		Louvers and Vents	
Questions		Access Flooring	
References for Further Study		Fireplaces	
<b>Division 8 DOORS, WINDOWS, AND GLASS</b>	222	Flagpoles	
Doors		Identifying Devices	
Metal and Metal-covered Doors		Lockers	
Wood Doors		Corner Guards	
Sliding and Folding Doors		Interior Partitions	
Windows		Sun Control Devices	
Builders' Hardware		Toilet and Bath Accessories	
Cabinet Hardware		Questions	
Glass		References for Further Study	
Sheet Glass		<b>Division 11 EQUIPMENT</b>	350
Float Glass		Built-in Maintenance Equipment	
Safety Glass		Miscellaneous Equipment	
Tinted and Coated Glass		Athletic Equipment	
Plastic Glazing Materials		Parking Equipment	
Glazing		Waste Handling Equipment	
Curtain Walls		Loading Dock Equipment	
Window Walls		Residential Equipment	
Questions		Questions	
References for Further Study		References for Further Study	



<b>Division 12 FURNISHINGS</b>	356	<b>Division 15 MECHANICAL SYSTEMS</b>	388
Artwork		Mechanical Trades	
Cabinets and Storage		Water-Distribution Systems	
Window Treatment		Water-Supply Piping	
Fabrics		Drainage Systems	
Furniture		Drain Pipe and Fittings	
Rugs and Mats		Sewage Disposal	
Seating		Fuel-Gas Piping	
Furnishing Accessories		Plumbing Fixtures	
Questions		Fire Sprinkler Systems	
References for Further Study		Heating Systems	
<b>Division 13 SPECIAL CONSTRUCTION</b>	366	Air Conditioning	
Audiometric Rooms		Solar Energy Systems	
Clean Rooms		Questions	
Instrumentation		References for Further Study	
Insulated Rooms		<b>Division 16 ELECTRICAL SYSTEMS</b>	422
Integrated Ceilings		Electrical Energy	
Nuclear Reactors		Power Generation	
Prefabricated Buildings		Services and Service Equipment	
Special-Purpose Rooms and Buildings		Wiring Materials and Methods	
Radiation Protection		Junction Boxes, Outlets, and Switches	
Sound Vibration Isolation		Lighting	
Swimming Pools		Emergency Lighting	
Questions		Fire and Smoke Detection	
References for Further Study		Questions	
<b>Division 14 CONVEYING SYSTEMS</b>	374	References for Further Study	
Dumbwaiters		<b>APPENDIX</b>	449
Passenger Elevators		<b>INDEX</b>	457
Elevator Safety Devices			
Elevator Operation and Controls			
Hydraulic Passenger Elevators			
Elevator Cars and Entrances			
Freight Elevators			
Hoists and Cranes			
Moving Stairs			
Moving Walks and Ramps			
Questions			
References for Further Study			



# Preface

The second edition of *Construction Materials and Processes* provides a thorough and practical groundwork for students of architecture and architectural, civil, and construction technology. The expanded and updated text, accompanied by many new illustrations, can also serve as a refresher and reference for practicing architects, engineers, contractors, subcontractors, and other workers who must be aware of new building materials and techniques.

A very significant change in this edition is the use of a special form of organization. The book is sectioned into 16 divisions instead of traditional chapters. These divisions are identical to the basic divisions of the Uniform System for Construction Specifications, Data Filing, and Cost Accounting. This system, developed by the Construction Specifications Institute, has received almost total acceptance throughout the U.S. and Canada.

The format of this edition thus makes it possible to relate manufacturers' literature and filing systems directly to the text. The changeover also allows for the inclusion of much new material covering specialties, equipment, furnishings, special construction, and conveying systems. In addition, the student or professional will find a list of references for further study at the end of each division as well as a greatly expanded Appendix at the end of the book listing organizations in the construction industry.

The need for a comprehensive, up-to-date text on materials and processes is readily apparent. Research and development have resulted in new materials, modifications of old ones, and new construction techniques. Governmental agencies such as HUD, OSHA, and ERDA have established new rules. Standards published by the American Society for Testing and Materials, the American National Standards Institute, the U.S. Bureau of Standards, Underwriters' Laboratory, Factory Mutual, and the National Fire Protection Association are pertinent. Noise pollution, air pollution, and other environ-

mental factors, along with their effects on construction practices, are important considerations. The use of fire detection and control devices reflects the increasing concern for human safety. New earthquake regulations require changes in long-accepted construction techniques.

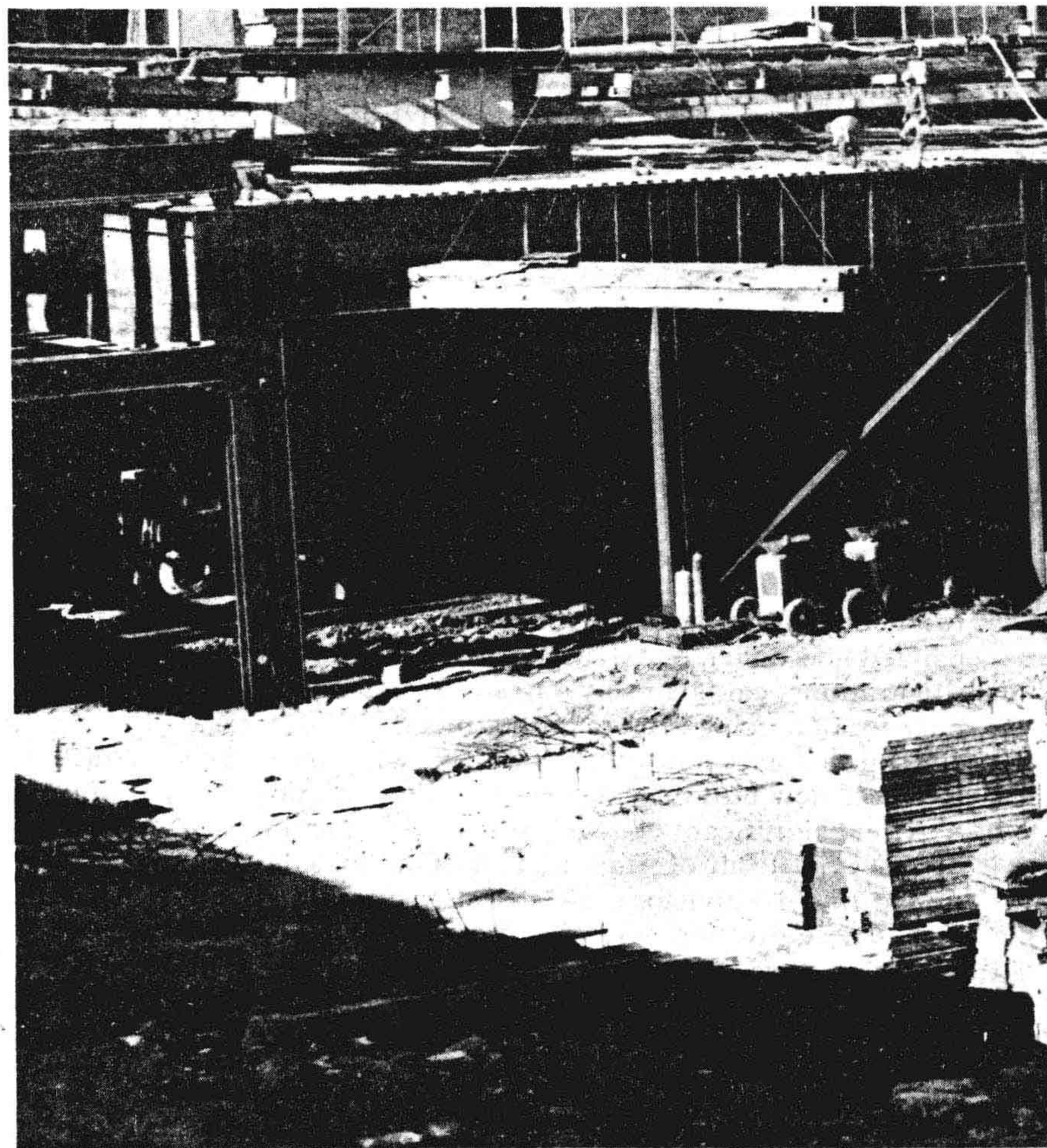
As the energy crisis becomes more acute throughout the world, attention is being given to new insulation standards and materials, including foamed plastic. In other applications, too, plastics are increasingly replacing traditional materials. Because of these developments, the text contains a complete section showing the derivation, chemical make-up, techniques of manufacture, and physical characteristics of the plastics most commonly used in the construction industry.

The changeover to the metric system in the United States is inevitable. National standards now include metric designations along with conventional English measurements. Much of the manufacturer's literature produced today gives metric equivalents. Many manufacturers are prepared to roll or shape materials to a new metric size and model building codes will soon be including metric information. In recognition of these changes, metric equivalents have been included in this edition wherever possible.

I would like to thank many individuals, manufacturers, and associations that have given generously of their time to review the new edition. Their suggestions, clarifications, and modifications were valuable. Acknowledgement is also made to the technical journals, especially *Construction Specifier*, and the monographs published by the Construction Specifications Institute. Finally, I wish to thank my wife, Evelyn, for her expert work in reclassifying material into the new format and the extensive typing required for this edition.

Don A. Watson





# Division 1

## **MATERIALS EVALUATION**

The evaluation and selection of materials become more difficult with each passing year. At one time it was possible to select a basic material, such as brick, stone, wood, or iron, and leave its assembly to the worker on the job. The designer must now contend with hundreds of new materials each year. Old materials are being put to new uses or are being combined with new materials to form new prefabricated or preassembled products. The processes of construction can no longer be separated from the materials themselves. Building systems that contain many basic materials must be evaluated as a whole, and not in terms of the individual components. Prefabrication is becoming more widely accepted by building-trade groups, although many of the newer building processes such as curtain-wall systems, lift-slab and tilt-up techniques of concrete construction, and integrated ceiling systems cross traditional trade jurisdictions. Building codes and zoning ordinances are

also being modified to accept new materials and sub-assemblies of materials.

## **REFERENCES**

There are many reference works, in both book and periodical form, to help the designer select materials and methods for assembly on the job site. Most basic materials are manufactured to rigid standards which specify their chemical and physical properties. Trade magazines present many useful articles by experts in various fields. Trade associations publish literature on new techniques and construction methods and discuss the problems that may arise in the use of specific materials.

Evaluation of factory-manufactured products that have proprietary formulations is more difficult. Virtually the only information available is that provided by the manufacturer's own literature, which often contains more sales promotion than factual data.





## GENERAL REQUIREMENTS

Even though manufacturers seldom dwell on the limitations of their products, few issue literature that is deliberately misleading. The designer must learn to evaluate products on the basis of their use in a particular project.

It is not enough to evaluate a product on its merits alone. It must be compatible with adjacent products and structural systems. The designer must also determine whether it conforms to standards and building codes governing construction in the particular area in which it is to be used.

### Building Codes

The materials to be selected for incorporation in a building project are governed to a great extent by local building codes. These codes have been established for the purpose of providing minimum standards to safeguard life, health, property, and public welfare by regulating and controlling the design,

construction, quality of materials, use and occupancy, location, and maintenance of all structures within a given political jurisdiction. For most projects the designer must consider these local codes his primary reference source in selecting materials and construction methods. He must determine which code or codes he will be working under and thoroughly familiarize himself with their requirements. He must then keep copies of all applicable codes close at hand for constant reference.

The first known building code was prepared by Hammurabi, king of ancient Babylon, in 2250 B.C. This code was written on a black tablet discovered about 70 years ago. It consists of six short sentences, the first of which stipulates the wage the builder was to receive. Converted into today's costs and wages, this would amount to approximately 10 cents a square foot. The remaining five sentences spell out the penalties that were to be imposed if the building collapsed. If the owner of the building was killed, the



architect (builder) was to be put to death. If the son of the owner was killed, the son of the architect was to be put to death. From this clear-cut performance code we have progressed to an estimated 18,000 local jurisdictions in the United States alone, which can and do promulgate their own building, electrical, and plumbing codes, some of which vary widely from each other and from standard national trade practices (see Fig. 1-1).

**model building codes** At the present time there are four model building codes, sponsored by four different organizations:

“Basic Building Code, Building Officials Conference of America, Inc. (BOCA), 1313 East 60th Street, Chicago, Ill. 60637.

“National Building Code,” American Insurance Association, 85 John Street, New York, N.Y. 10038.

“Southern Standard Building Code,” Southern Building Code Congress, 116 Brown-Marx Building, Birmingham, Ala. 35203.

“Uniform Building Code” (UBC), International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, Calif. 90601.

None of these national and regional codes has any authority until it is adopted through legislative action by a municipality, county, or state. When a city has passed an ordinance adopting one of the codes, by reference, this becomes the local code. In most instances a particular edition of the code is adopted, and this edition remains the official code until a new resolution is passed adopting a later edition. As a result, while it is extremely rare, one city may be operating under, say, the 1967 edition of a particular model code while an adjacent city is operating under the 1947 edition of the same code. Many cities and counties adopt the basic code with modifications that they feel are necessary in their locality. These modifications usually revise only the administrative provisions. Thus, to be sure that the materials and construction techniques he selects will comply with all relevant codes and regulations, the designer must determine which basic code is in effect, which edition of that code is in effect, what modifications are in effect in that particular area, and what other agencies will be concerned with the project.

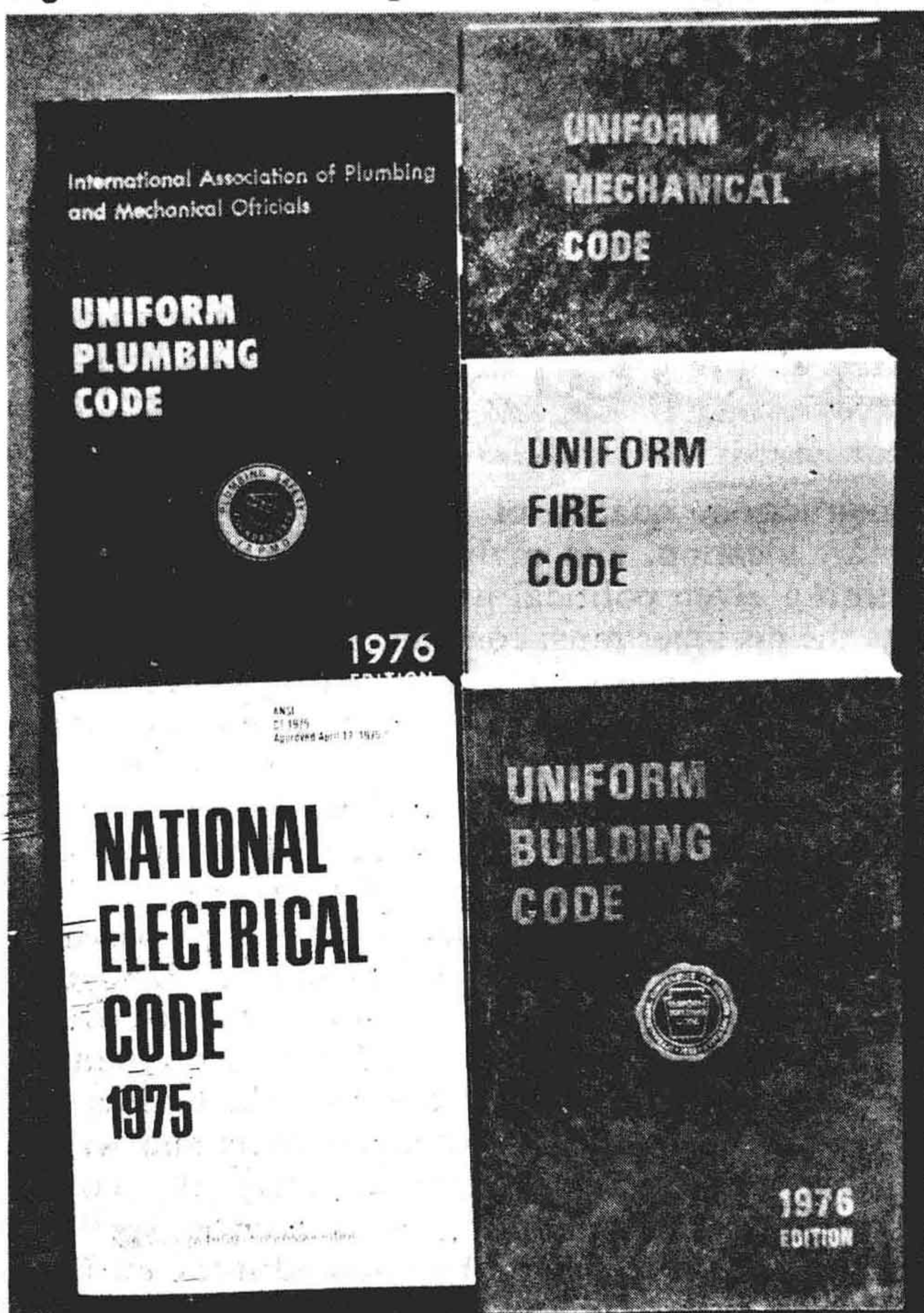
**specialized codes** Most city and regional building codes do not cover electrical and mechanical work. Cities may adopt separate codes for these sections, such as “The Uniform Plumbing Code,” published by the International Association of Plumbing and Mechanical Officials, “The Uniform Mechanical Code,” published jointly by the International Association of Plumbing and Mechanical Officials and the International Conference of Building Officials, or the “National Electrical Code,” published by the National Fire Protection Association.

Most states have also established safety codes that apply to construction. These codes cover a wide range of subjects, such as fire protection, wall openings, scaffoldings, lifts, electrical hazards, and protection of the public. The designer must be sure that his building conforms to the requirements of the safety codes in force in that particular area.

Certain local agencies, bureaus, commissions, or committees may have a say in the design and materials used for a particular project. City planning committees, art commissions, air-pollution control districts, water-pollution control boards, fire departments, public-health departments, the Department of Health, Education and Welfare (HEW), the Department of Housing and Urban Development (HUD), and many others may have to be consulted.

**uniformity of codes** Because of the number of codes in use and their varying requirements, specifications are often confusing and inconsistent. It is difficult to understand why a particular type and grade of wood will support 1800 psi in one location but will support only 1600 psi on the other side of a political boundary. Some progress in unifying codes is being made by the National Conference of Building Officials, a coalition of officials from all 50 states

Fig. 1-1 Model building code and specialty codes.





working under the auspices of the National Bureau of Standards. This committee is attempting to reduce the hundreds of codes that may exist within a state to one broad standard, so that designers and builders working anywhere within the state will know what is approved and where to go for information, appeals, and testing.

### Manufacturers' Literature

Literature that is provided by manufacturers must be evaluated carefully. The advertising that appears in both general publications and trade magazines tends to present products in terms of eye-catching photographs of a pretty girl holding a cast-iron sewer pipe or admiring a can of roofing compound, with catchy wording intended to influence the general public. A great deal of this type of promotional literature arrives daily on the architect's desk and goes directly into the wastebasket. However, well-done, colorful promotional literature of a nontechnical nature can be useful. Clients may have to be sold on a product when they cannot visualize how it will look in finished form. Photographic examples of buildings usually cite the architects and engineers, who can be contacted for further information.

Most large manufacturers also distribute to architects and engineers catalogs which give information on all their products. These may be bound in a hard cover and indexed so that any product manufactured by the company can be located easily. As the material becomes outdated or products are superseded by new items, the catalogs are replaced. Some manufacturers distribute hardback ring binders which their architectural representatives keep up-to-date continually.

**Sweet's Catalog Files** Good references for a designer or specifier are Sweet's Catalog Files. There are actually five Sweet's Catalog Files, as follows: Architectural Products for General Building, Products for Industrial Construction and Renovation, Products for Interiors, Products for Light Residential Construction, and Products for Engineering.

The Architectural Products for General Building Catalog File contains over 15,000 pages of catalog information from about 1200 manufacturers. The Products for Engineering Catalog File is the newest Sweet's File. It consists of both the Comprehensive and Summary Editions. The Comprehensive Edition is sent to the biggest, most active offices, whereas the Summary Edition goes to smaller offices. The Products for Light Residential Construction File is sent to the smaller offices, which are primarily involved in the design of residences. These catalog files are available from: Sweet's Division, McGraw-Hill Information Systems Company, 1221 Avenue of the Americas, New York, N.Y. 10020.

The catalog files are published and distributed on the basis of contracts with the manufacturers. They are

available only to those doing a given volume of an appropriate type of business. Sweet's Division, McGraw-Hill Information Systems Company will send applications on request, which the architect or engineer must return to request the catalog file.

Sweet's Architectural Products for General Building Catalog File consists of literature and catalogs furnished by manufacturers or distributors of building products. The information is filed under 16 divisions, according to the Uniform Construction Index. Each division is divided into sections and identified by a distinct code. The material covered in each book is listed by division and section numbers on the back of each book. Three indexes to the entire catalog file are included in each book. The first lists firm names in alphabetical order. The second lists products coded by section number of firm names, for example, 3.4/Gr. The third index lists trade names coded by section number and firm names.

Sweet's Catalog Files do not solve all design and material selection problems. They contain literature from all over the United States. However, the fact that an item does not appear in the file does not mean that it is not available. Many companies, both large and small, rely on their own individual catalog programs, especially binders, in place of Sweet's. Most important firms, however, do participate in the catalog files.

A second caution is that some of the products that are listed are not readily available in all parts of the country. The designer must make sure there is a local distributor or representative before specifying an item. Users of the catalog files now have an easy way to determine whether a product therein is locally available. In 1974 Sweet's implemented a national service called "Buyline," which enables any file recipient to call a toll-free number to find out who is the local representative or distributor for any manufacturer in Sweet's.

### TRADE ASSOCIATIONS

There are many groups of manufacturers, applicators, or contractors formed for joint promotion of the correct use of their products or services. These groups may call themselves associations, bureaus, institutes, councils, societies, or producers. Some of these organizations are formed to promote a particular product or trade; however, most are concerned with improving quality, setting standards, establishing stock sizes, and promoting higher standards of work.

A designer or specifications writer can usually obtain information on products or methods of application from one of these associations. A partial list of the hundreds of such groups is given in the Appendix. Some are nationwide, and some are local only. Many of the associations listed as national organizations have local chapters or representatives. Many of them publish literature of general interest regarding



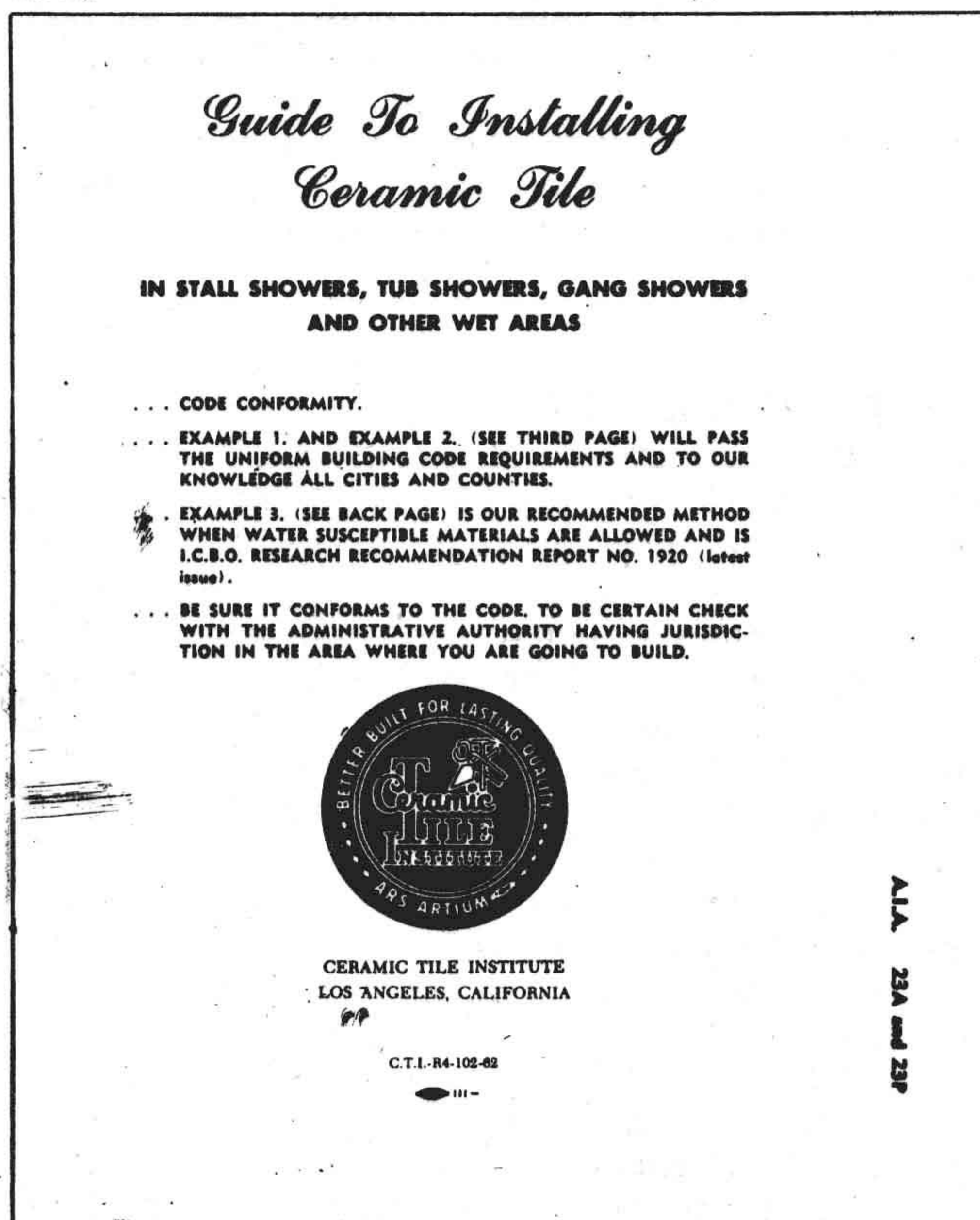
## 6 Construction Materials and Processes

their services or products. Information published by reputable trade associations is undoubtedly some of the best available (see Figs. 1-2 and 1-3). The data are usually reliable as to quality, since most trade associations are formed to improve or protect an image. Others furnish technical help, reference material, and suggested standard specifications. Many of these organizations are commonly identified by their acronyms. For example, the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc., is known as ASHRAE, Underwriters' Laboratory as UL, and the Ceramic Tile Institute as CTI.

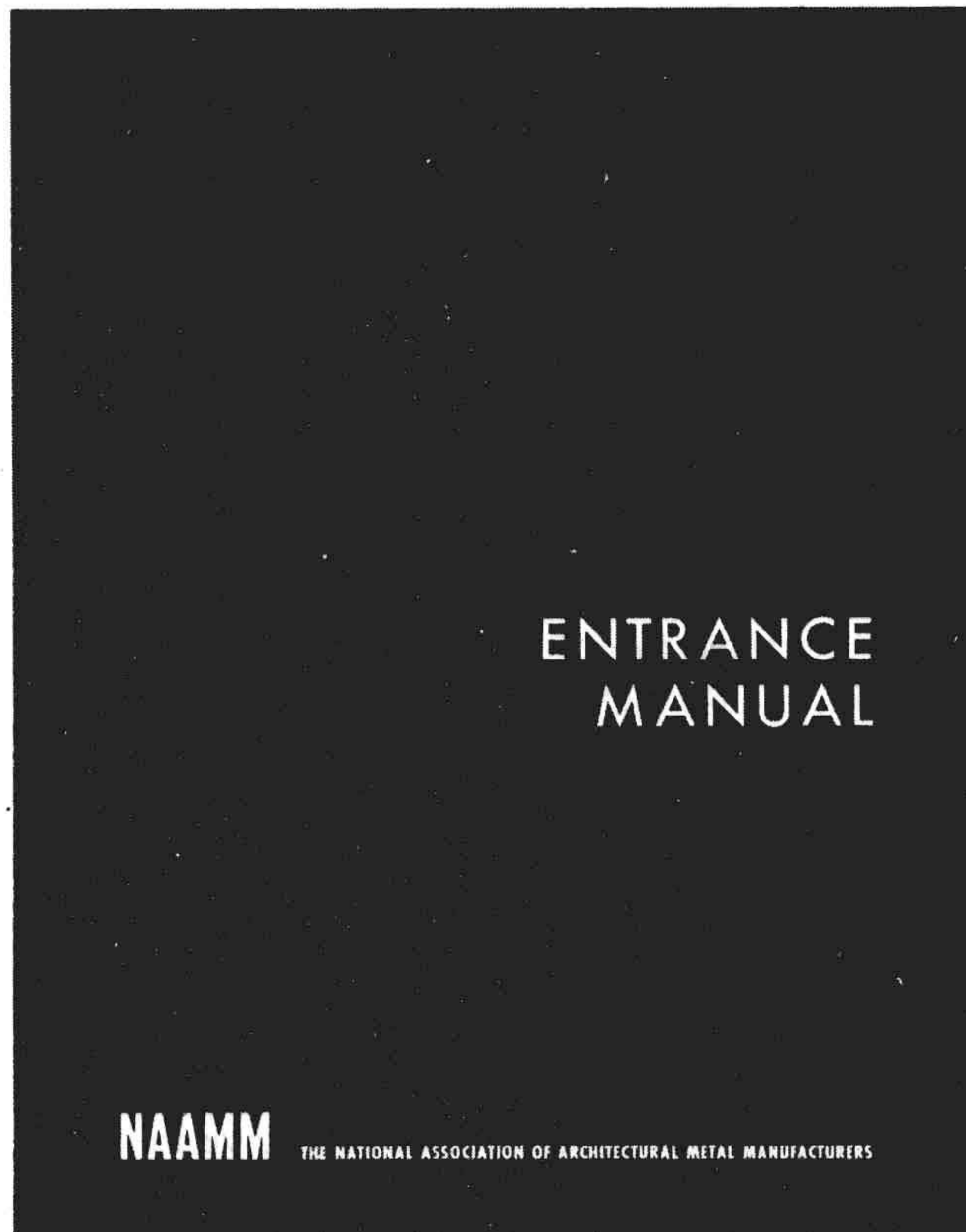
### Self-policing of Construction Trades

Many quality-control agencies have been set up that will stamp and certify the quality of a material; however, these standards are valueless if the material is installed incorrectly. What is needed is a trade inspection team that can certify the entire operation from design to installation. If such a team is to operate successfully, it must include all factions of the trade, such as engineers, manufacturers, contractors, union officials, and inspectors. For example, the Ceramic Tile Institute, which operates in southern California, one of the largest and fastest-growing construction areas in the world, has set up a non-profit organization called Bonded Tile Installations

**Fig. 1-2** An association standard. (*Ceramic Tile Institute.*)



**Fig. 1-3** An association publication. (*National Association of Architectural Metal Manufacturers.*)



(BTI), which provides an unbiased professional consulting service, inspection, and bonding for architectural firms and their clients (see Fig. 1-4).

The Woodwork Institute of California (WIC) has had a quality-control system in effect for the past 15 years. This organization publishes a regularly revised "Manual of Millwork" for use by designers and manufacturers, setting forth grades and qualities of millwork. Most of their inspection is done in the factory and not on the job site, although they will reinspect on the job site by request.

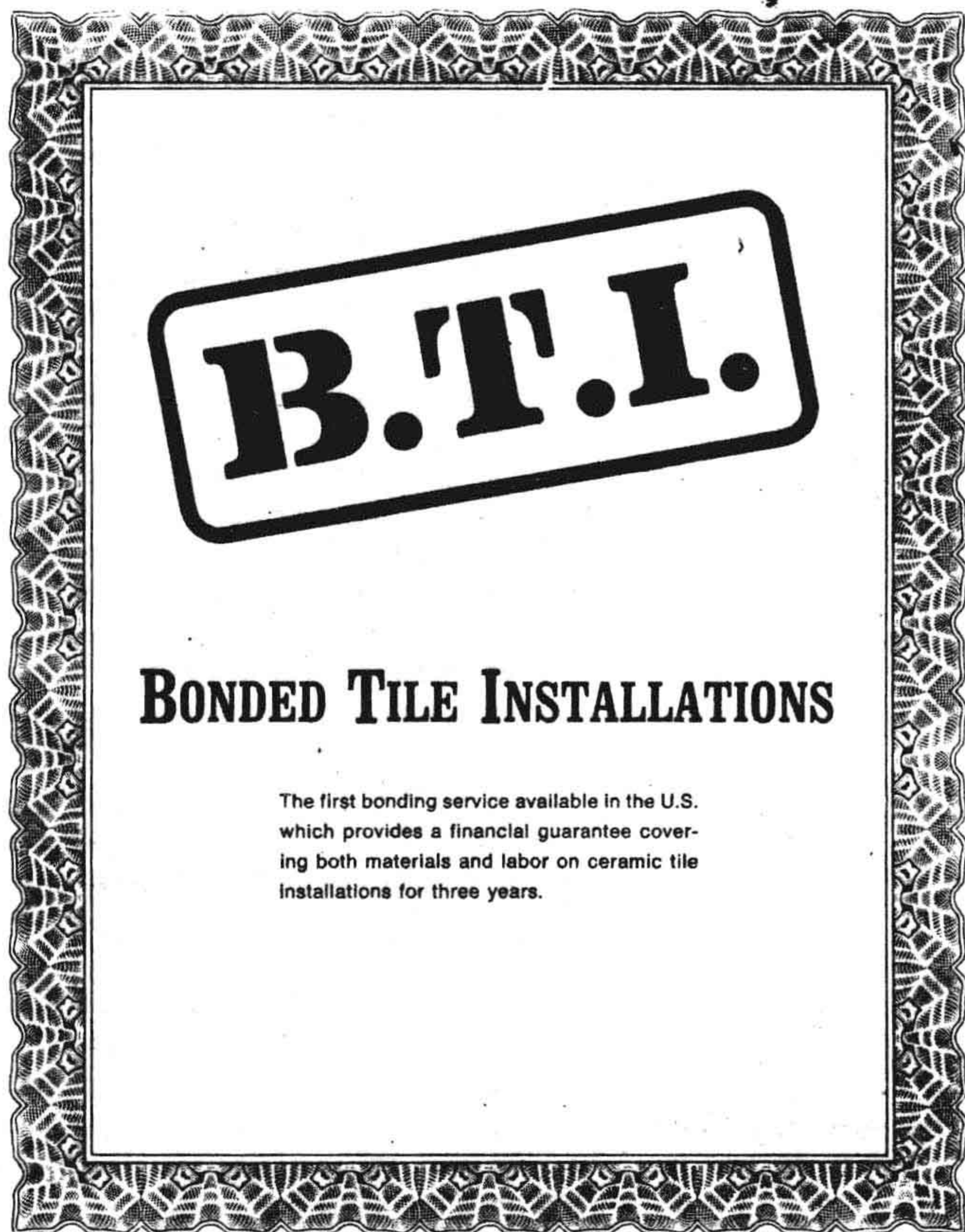
Many other trade groups throughout the United States are setting up similar trade inspection teams. The designer or specifier would be wise to encourage more of this type of activity. It is often difficult to obtain a true evaluation of materials and installation methods from individual manufacturers.

### CONSTRUCTION SPECIFICATIONS INSTITUTE

The Construction Specifications Institute (CSI) is an organization of specifications writers, architects, engineers, manufacturers' representatives, contractors, building officials, and others interested in the preparation and utilization of specifications in the construction industry. Its members also conduct studies and technical research to "improve and implement the science of communications in construction technology through service, education



**Fig. 1-4** An association bonding program. (*Ceramic Tile Institute.*)



and research.” The results of their research are published as technical studies or monographs in the CSI’s national monthly magazine, *The Construction Specifier*. These studies on many materials and construction processes are prepared by committees from local chapters, composed of members from industry and professional members of the CSI, and are valuable reference sources on various phases of manufacture, supply, installation, and use of building products. The monthly magazine also contains interesting articles on materials and installation methods.

The CSI has over 10,000 members in more than 100 chapters throughout the United States. Valuable information on new materials and new and improved construction techniques is presented to members by panels of experts from industry at monthly chapter meetings. Regional and national conventions and conferences allow interchange of ideas and give the members an opportunity to hear outstanding authorities in the construction industry. In 1970 the first student chapter of the CSI was formed at California Polytechnic State University San Luis Obispo. Materials, construction information, and literature are provided for architectural and engineering students. Panels of experts from the entire state travel to the college to help the students in their study of materials,

processes, and the preparation of construction documents.

Information on CSI publications and activities is available from Construction Specifications Institute, Inc., Suite 300, 1150 17th Street, N.W., Washington, D.C. 20036.

### CSI Format for Construction Specifications

In 1963 the CSI, as the result of extensive meetings throughout the United States and comments and criticism by members of the construction industry, adopted “The CSI Format for Building Specifications.” This document was revised and enlarged in 1965 and published as “The CSI Format for Construction Specifications.” This format arranges the information to be included in a set of construction specifications into 16 basic divisions, with general and specific sections in each division. The division headings and numbers are identical for every set of specifications. The work of a single trade, the work done under a single contract, or a basic unit of work is grouped in a technical section or a trade section. Several trade sections are grouped in each division.

### Uniform System

For several years the CSI participated in a Joint Industry Conference devoted to the development of a data-filing and -retrieval system that would meet the pressing needs for a better and faster method of classifying, filing, and identifying technical data. It was agreed that a data-filing system based on the specifications would be the most adaptable to the rapidly multiplying new materials and techniques in construction. This system was further expanded to include a specifications outline and a contractors’ cost-accounting guide. The resulting “Uniform System for Construction Specifications, Data Filing & Cost Accounting,” based on the CSI 16-Division Format, was published jointly by the American Institute of Architects, the Associated General Contractors of America, the Construction Specifications Institute, and the Council of Mechanical Specialty Contracting Industries. Many other associations, as well as municipal and governmental agencies, have adopted this system, and most manufacturers identify their products on this basis for ease of filing and retrieval.

The Uniform System provides for product literature and related material to be filed under one of the 16 divisions shown in Table 1-1.

This is only a partial listing of the items that are included under each division. A complete listing, along with a keyword index that can be used to locate the proper grouping of particular products, is given in “The Uniform System for Construction Specifications, Data Filing & Cost Accounting,” Document 001a, or “The CSI Format for Construction Specifications,” Document 001, available from: Construc-



TABLE 1-1 Uniform filing system

Division	Description	Division	Description
1. General requirements	Encompasses certain aspects of the job which are the general contractors' responsibility and are often included in the contract under general conditions or special conditions	10. Specialties	Prefabricated products and proprietary devices such as chalkboards, demountable and moveable partitions, firefighting devices, fire-place equipment, flagpoles, signs, lockers, sun-control devices, toilet and bath accessories
2. Site work	Includes work performed on the site, such as clearing, grading, excavating, underpinning, drainage, site utilities, roads and walks, and lawns and planting	11. Equipment	Bank, ecclesiastical, commercial, educational, laboratory, medical, food service, and restaurant equipment; residential equipment, including all kitchen cabinetwork, countertops and splashes of plastic laminates; bath laboratories and cabinets (excluding medicine cabinets); built-in range tops, ovens, refrigerators, dishwashers, garbage disposals; and prefabricated range and oven exhaust systems
3. Concrete	Concrete formwork, reinforcing, and precast and cast-in-place concrete	12. Furnishings	Artwork, prefabricated cabinets and fixtures, blinds, shades, drapery, carpeting, furniture, and seating
4. Masonry	Mortar, unit masonry, stone, and masonry restoration	13. Special construction	Special-purpose rooms, integrated ceilings, prefabricated structures, storage vaults, and swimming pools
5. Metals	Structural steel, open-web joists, metal stud-and-joist systems, miscellaneous metal items manufactured to standard details and sizes, ornamental wrought metal or die-cast nonferrous metalwork such as grilles and louvers (sheet-metal work is usually included in division 7)	14. Conveying systems	Dumbwaiters, elevators, moving stairs, lifts, hoists, cranes, materials-handling systems
6. Carpentry	Wood and wood framing materials, rough and finish carpentry (excluding cabinetwork)	15. Mechanical systems	Plumbing systems, heating systems, fire-extinguishing systems, air-conditioning systems, and refrigeration
7. Moisture protections	Waterproofing, dampproofing, thermal insulation, roofing materials, sheet metal and flashing, skylights, caulking, and sealants	16. Electrical systems	Electrical services and distribution systems, lighting fixtures, communications systems, electrical power equipment, electrical heating or cooling systems
8. Doors, windows, and glass	Doors, windows, finish hardware, weatherstripping, glass and glazing, curtain walls, window walls, storefront systems		
9. Finishes	Lath and plaster, tile, terrazzo, acoustical surfacing materials, flooring, wall coverings, painting		

tion Specifications Institute, Inc., Suite 300, 1150 17th Street, N.W., Washington, D.C. 20036.

### Spec-Data

CSI has developed a program that offers specifications writers and designers specific information on materials in a standard format. This program, called Spec-Data, was originally set up by the Producers Council and was later taken over by CSI.<sup>1</sup> Manufacturers subscribing to this service present information on their products in a form that enables the designer or specifications writer to evaluate any product quickly and easily. The standard format includes the product name, manufacturer, product description,

<sup>1</sup>The description of Spec-Data, Comspec, and Concom is adapted from material supplied by the Construction Specifications Institute and the Construction Sciences Research Foundation.

limitations and advantages of the product, sizes and colors available, and other technical data necessary for proper installation (see Figs. 1-5 and 1-6).

**Spec-Data I** This is the only method in the U.S. for the preparation and distribution of purely technical information in an objective, definitive format. Recipients and users are CSI members who are specifying architects, specifying engineers, specification writers, consultants, draftsmen, and contractors. They use Spec-Data for product evaluation and selection; preparation of preliminary and final specifications and working drawings.

The format to be followed in each Spec-Data unit provides the information the specification writer needs. It provides for ten major headings. They are: (1) product name; (2) manufacturer; (3) product description; (4) technical data; (5) installation; (6)



**Fig. 1-5** A Spec-Data sheet. (*Construction Specifications Institute.*)

1. PRODUCT NAME		Type: These are interior spray paints with fast-drying overspray characteristic. See analysis above for exact type of materials as the flat, semi-gloss and high gloss are of varied constituents.	
<b>PITTSBURGH PAINTS</b>			
SPEEDHIDE® Dry-Fog Spray Finishes 6-114, 6-115, 6-116			
2. MANUFACTURER		Size: 6-115 is available in five-gallon pails and 55-gallon drums. 6-114 and 6-116 are available in gallons, five-gallon pails, and 55-gallon drums.	
PPG INDUSTRIES, INC. Coatings and Resins Division One Gateway Center Pittsburgh, Pennsylvania 15222 Phone: (412) 434-3131		Colors: These products in the Speedhide Line are calibrated in strength and color acceptance to permit machine tinting to the pastel colors of the PPG Custom Color System. Several hundred colors available.	
3. PRODUCT DESCRIPTION		4. TECHNICAL DATA	
Basic Uses: Interior application only. Quick refinishing of large industrial or commercial ceilings or wall areas by spray painting represents the chief use for these products.		Viscosity: Semi-Gloss and Flat ready-to-spray. Gloss may require thinning.	
In painting, the term "dry-fog" means that, under normal conditions of application the overspray from these paints does not stick, but falls to the floor as a dry dust which may be swept up without damaging the surfaces on which it has fallen. This means that large industrial ceilings of beams, girders, trusses, corrugated metal, etc. can be painted without the costly operation of shielding floors and equipment from paint overspray. (Caution: Some types of machinery and equipment may still require covers as a protection against possible damage to working parts such as bearings, etc.) Fast drying permits areas to be put back into service quickly.		Shade: Flat: 5 maximum, by 60° meter Semi-Gloss: 20-40, by 60° meter Gloss: 85 minimum, by 60° meter	
Limitations: These paints are intended for interior spray application only. They are best suited for ceiling and wall spraying — and are not recommended for floors.		5. INSTALLATION	
Composition and Materials: Film-forming solids, percent by volume: Semi-Gloss 48.8, Flat 44.8, Gloss 41.4.		Surface Preparation: Surfaces to be painted must be free of dirt, grease, rust, and loose paint. Point up surface voids.	
6-114 6-115 6-116		Priming: Spot-priming may be done with Speedhide Quick Drying Enamel Undercoater, which is also the preferred primer for bare wood. On galvanized metal, and on gypsum board panels bound with zinc-coated metal, use Speedhide Galvanized Steel Primer in White. On plaster, wallboard, and masonry use Wall Primer Sealer.	
Type	Semi-Gloss	Flat	Gloss
Pigment	54.1	60.2	26.9
Titanium Dioxide, C.I.	6.1	—	100
Titanium Calcium Pigment	93.9	45.4	—
Silica and Silicates	—	33.7	—
Calcium Carbonate	—	20.9	—
Vehicle	45.9	39.8	73.1
Non-Volatile	40.2	26.5	44.6
Volatile	59.8	73.5	55.4
In the Semi-Gloss and Flat paints the vehicle non-volatile is alkyl resin, and the volatile is petroleum spirits, including VM&P naphtha with a flash point in the 20-80° F. range. In the Gloss, the binder is a vinyl-toluene alkyl, using a low flash solvent.			
Method of Application: By spray only. Conventional, hot spray, and airless types have been used successfully.			
Thinning: Speedhide Dry-Fog Gloss may require addition of up to one pint of Xylol per gallon. Flat and Semi-Gloss should require no thinning under normal conditions. If atmospheric conditions cause these products to dry too fast or too slow, additions of an appropriate thinner may help to control performance.			
Spreading Rate: 200 to 250 square feet per gallon (including an allowance for spray loss).			
Drying Time:			
	To Touch	To Handle	To Re-coat
6-114	60 min.	3-4 hrs	overnight
6-115	15 min.	30 min	overnight
6-116	30 min.	1 hr.	3-4 hrs
Overspray: From dry fog material dries at varying distances from the area being sprayed, dependent upon the type of each material. For example, under NORMAL conditions of temperature and humidity (70°F., 50% R.H.), material is dry enough to avoid sticking when it falls. 6-114 Dry-Fog Semi-Gloss: free-fall: 6-7 ft 6-115 Dry-Fog Flat: free-fall: 4-5 ft 6-116 Dry-Fog Gloss: free-fall: 10 ft			
Equipment Clean-up: Mineral spirits is satisfactory for clean up of equipment used with Dry-Fog Flat or Semi-Gloss. Xylol is required for clean-up of Dry-Fog Gloss.			
Handling Precautions:			
WARNING! Flammable. Keep away from heat and open flame. Use with adequate ventilation. Avoid prolonged or repeated contact with skin and breathing of vapor or spray mist. Do not take internally. Close container tightly after use. Keep out of the reach of children.			
6. AVAILABILITY AND COSTS		The ten-point SPEC-Data® format has been reproduced from publications copyrighted by CSI, 1964, 1965, 1966, 1967, and used by permission of The Construction Specifications Institute, Inc., Washington, D.C. 20036	
Availability: 6-115 is packaged in five-gallon pails and 55-gallon drums. 6-114 and 6-116 are packaged in gallons, five-gallon pails, and 55-gallon drums. The one-gallon and five-gallon containers are immediately available from any Pittsburgh Paint Center. Fifty-five gallon drums are quickly obtainable on order.		(Over)	

availability and costs, (7) guarantee, (8) maintenance, (9) technical services, and (10) filing systems, with appropriate subheadings. They must be followed in sequence.

New and revised units are distributed, individually addressed, in February, May, August, and November. The logos, format, distribution, recipient filing, and use are the heart of Spec-Data I, but it serves other purposes. Manufacturers use it for advertising and catalog inserts, direct mail promotion, sales representative literature, use by distributors, convention and exhibit literature, press releases for new products, and technical handbooks. They also offer Spec-Data units in advertisements to draw sales leads.

**Spec-Data's Manu-Spec** This is the proprietary specification written according to the copyrighted CSI 3-Part Section Format, which has been in use since 1969. It answers the need of many manufacturers to get their sample specifications into the hands and files of the specification writer, who may then incorporate the manufacturer's proprietary specification directly into the project specification. Manu-Spec is distributed to the same audience which receives Spec-Data I and can be filed adjacent to Spec-Data I because of the marginal definitions

and five-digit filing number. Distribution months are the same as for Spec-Data I: February, May, August, and November. Manu-Spec is available only to those manufacturers and products in Spec-Data I.

**Spec-Data II** CSI's Spec-Data program is now being expanded to a data-retrieval system called Spec-Data II. Materials information obtained from manufacturers is put into a standard form, stored in computer memory banks, and reproduced on microfilm. In 1970 the catalog section contained over 450,000 pages of manufacturers' literature. This system includes a unique product-selector feature, which lists primary product characteristics, as extracted from manufacturers' literature. Products having similar characteristics can be identified quickly, and specific catalog pages can be located quickly for more detailed information. The user can make a dry print, in 6 s, of any manufacturers' catalog page. The products are indexed by manufacturer, brand name, catalog, and according to the computer-generated product selector, which is arranged in the 16-division CSI format. Further information is available from: Information Handling Services, Division of Indian Head, Inc., 5500 South Valentia Way, Denver Technological Center, Englewood, Colo. 80110.

**Spec-Data Annual Index-Catalog** The Spec-Data Annual Index-Catalog provides the manufacturer with an opportunity to augment the impact of Spec-Data I and Manu-Spec with product promotion. The index portion contains a listing of all current Spec-Data I and Manu-Spec, organized according to the Uniform Construction Index Data Filing Format and an alphabetical list of participating manufacturers. Members can use the index and the alphabetical listing of manufacturers to keep their files up to date. Product promotion is positioned within the index. Members use the order card in the Index-Catalog to order units (see Fig. 1-7).

### Comspec

As buildings become increasingly complex, new structural systems are developed, new materials are put on the market, and new installation techniques are adopted, it becomes ever more important to establish effective communication systems within the construction industry. Comspec, sponsored by CSI and the Construction Sciences Research Foundation (CSRF), is a method of storing and manipulating specifications text. It is available through the nationwide shared-computer facilities of Browne Time Sharing, Inc. Comspec has a large computer-stored library of nationally used master specifications that are available to Comspec users. Comspec will also store private master specifications developed by individual firms. The individual firm can recall its individual master specification along with any of the public libraries stored in the computer.



**Fig. 1-6** Spec-Data II. (*Construction Specifications Institute.*)

1771

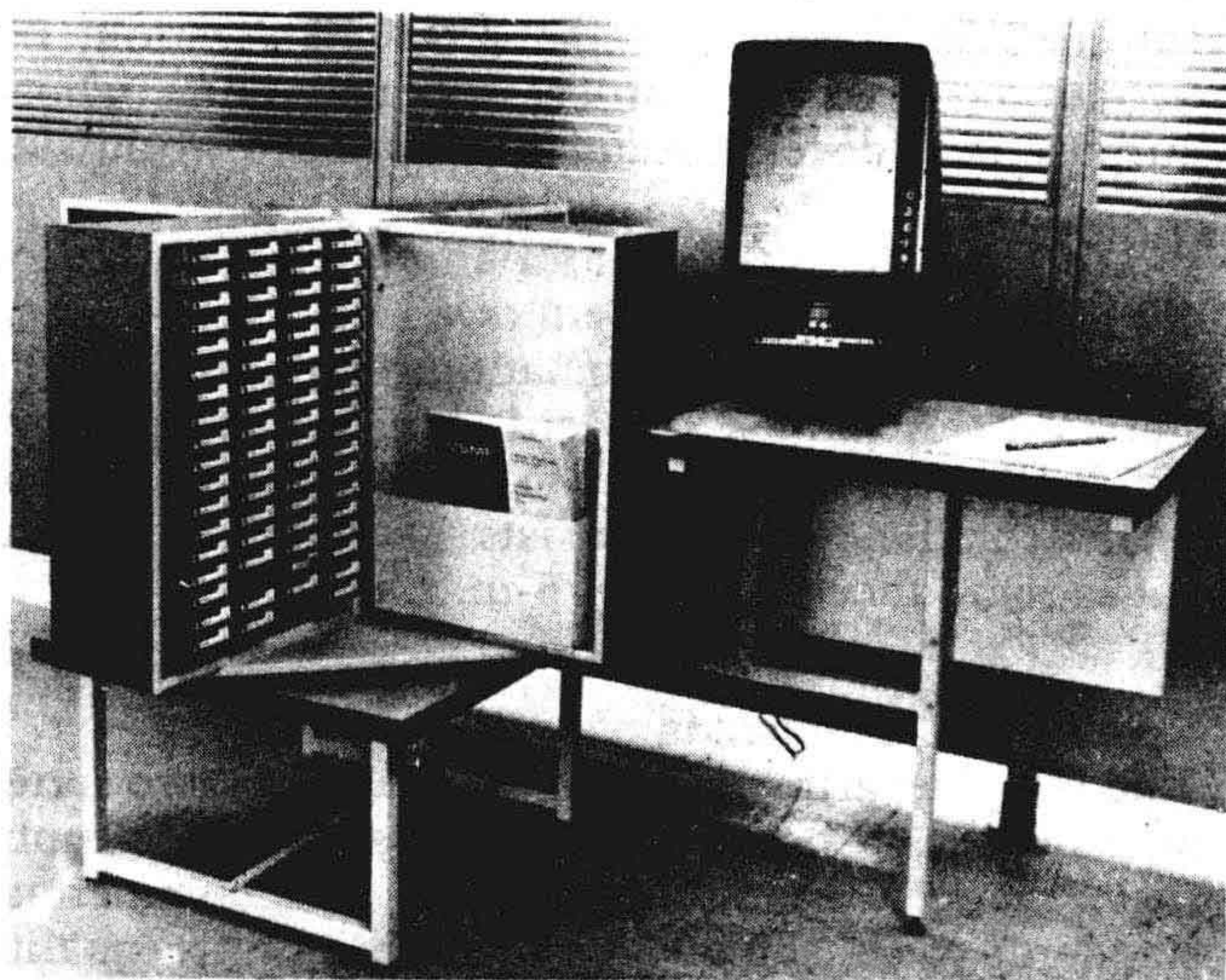
**A Selectric typewriter with a standard keyboard is linked by local telephone to the computer. Text, or modifications of text, are sent to the computer, where it is corrected and printed out on a high-speed printer that is capable of printing out 500 pages of corrected copy per hour. Copies of the printout of the final specifications are returned to the user for reproduction. The final printout can also be transmitted by telephone back to the user's office for printing at the typewriter itself.**

## Concom

CSI and CSRF are still trying to improve the language of users of building products and also the methods they can use for communicating their choice. The Concom program was founded by CSRF to explore possible solutions to communication problems within the industry. It has established six levels of computer sophistication in industry communications. The sixth level would allow a designer to draw with a computerized pen on a TV-like screen. The



**Fig. 1-7** A personal Spec-Data station. (*Information Handling Services, Inc.*)



drawing would ask a series of questions which would be instantly answered with details and materials. Or it might produce alternative sets of plans and specifications for a given building type. Comspec and Concom help specification writers to analyze materials.

## REFERENCE STANDARDS

Many organizations write standards that can be included in specifications by reference. They may also be included in building codes by reference. In order to reduce the bulk of a building code, many cities have set up standards or use established standards to which they refer in their regularly published codes. These standards are published in a separate volume. For example, the 1967 edition of the "Uniform Building Code," published by the Pacific Coast Building Officials Conference, in referring to the quality of portland cement, states that: "Portland cement shall conform to UBC Standard Number 26-1-67." Volume II of the "Uniform Building Code" gives this standard in full. The standard is identical to ASTM Standard C150-67, which can be found in "ASTM Standards in Building Codes," published annually by the American Society for Testing and Materials.

## Association Standards

Trade-association standards and specifications are produced by member companies or individuals within the trade. These standards, which are formulated by experts in the particular field, are constantly updated to keep them abreast of the latest materials and techniques in the field. When the trade-association standards are included in specifications

by reference, firms that do not belong to the association are not excluded from furnishing the product, as long as the product conforms to the standards set up by the association. Copies of association standards can be obtained without cost from most associations. Examples of trade-association standard specifications are: "Aluminum Prime Windows: Double-hung (and Single-hung) Windows, for Residential-type Buildings," Specification DH-B1, published by the Architectural Aluminum Manufacturers' Association (AAMA), and "Standard Specifications for Installation of Ceramic Tile with Water Resistant Organic Adhesives," published by the Ceramic Tile Institute.

**American Society for Testing and Materials** The American Society for Testing and Materials (ASTM) was formed in 1902 for the "promotion of knowledge of materials of engineering, and the standardization of specifications and the method of testing." It now has over 25,000 members and has published more than 5600 standards. ASTM membership consists of both producers and consumers. Publications are issued by committees of producers and consumers formed to establish joint standards for the industry. Committees are constantly studying new materials, new applications of old materials, and new testing methods for the use of industry. ASTM publishes an annual "Index to Standards," which lists all available standards (see Fig. 1-8). The title page of this index states that "single copies will be sent on request to those indicating a need for it in construction design... and related activities in the materials field."

ASTM books of standards consist of 48 separate parts, each of which covers a specific field of interest. The 1976 edition consisted of 33,000 pages of standards which apply to design, manufacturing, construction, and maintenance. Most large architectural and engineering offices purchase complete sets of these standards as they are published. Every office should have a copy of the current edition of "ASTM Standards in Building Codes." This book contains all standards that have been adopted by reference in the major nationally recognized building codes. ASTM also sells, at nominal prices, copies of separate standards for individual materials or testing methods. The annual index of standards is very convenient for locating information on materials or testing procedures. Single copies are available for \$5.00 from: American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

**American National Standards Institute** The American National Standards Institute (ANSI), founded in 1918 as the American Engineer Standards Committee, was later expanded to include standards of all types, and in 1928 it was reorganized as the American Standards Association (ASA). In