The Professional Practice of Architectural Working Drawings

THIRD EDITION

Osamu A. Wakita, Hon. A.I.A.
Professor of Architecture, Los Angeles Harbor College

Richard M. Linde, A.I.A. Architect
Richard M. Linde & Associates, Inc.

JOHN WILEY & SONS

The Professional Practice of Architectural Working Drawings

The Professional Practice of Architectural Working Drawings

THIRD EDITION

Osamu A. Wakita, Hon. A.I.A.
Professor of Architecture, Los Angeles Harbor College

Richard M. Linde, A.I.A. Architect
Richard M. Linde & Associates, Inc.

JOHN WILEY & SONS

This book is dedicated to the students of architecture and to our families.

This book is printed on acid-free paper. ♾

Published simultaneously in Canada.

Library of Congress Cataloging-in-Publication Data

Wakita, Osamu A.
The professional practice of architectural working drawings / Osamu A. Wakita, Richard M. Linde.—3rd ed.
p. cm.
ISBN 0-471-39540-4 (alk. paper)
1. Architecture—Designs and plans—Working drawings. I. Linde, Richard M. II. Title.

NA2713 .W34 2002
720′.28′4—dc21 2002003719

Printed in the United States of America.

10 9 8 7 6 5 4 3 2 1

CONTENTS

PREFACE

This book is designed to teach attitudes, basic drafting skills—both hand and computer-aided (CAD) skills, and fundamental concepts of architectural drafting to persons who will benefit from this information in their professional lives. Beyond this, the authors hope to communicate to readers an understanding of architectural drafting as a means of graphic communication, that is, a language. The professional architect or draftsperson needs a clear and fluent command of the language of architectural drafting.

With the advent of the computer, a new way of approaching working drawings has evolved—that of drawing *full-scale* buildings. Previously, we would draw floor plans, for example, at $\frac{1}{4}$″ = 1′0″. The drafter would have to understand the size of a structure in a fraction of its original size. We presently draw buildings in such a fashion that the computer monitor becomes a type of window through which we are able to view full-size buildings in space. Buildings are drawn in 3-D and rotated into a plan and elevation, or rotated and sliced to produce sections, framing, and floor plans. This rotation and slicing process helps the architectural technician and student better understand what the construction documents entail.

The Professional Practice of Architectural Working Drawings, third edition, is divided into three parts. Part I, "Professional Foundations," consists of Chapters 1 through 7 and is designed to provide basic information about drafting equipment, the process via computer-aided drafting (CAD), foundations in building a better strategy using CAD, office practice and procedures, fundamental skills, and an understanding of the evolution of construction. In this edition, Chapter 3 deals with the standards used in CAD and its impact on architectural drafting. There is a new Chapter 4 on environmental and human considerations, and a chapter dealing with the methods of construction and the various materials used in building—wood, masonry, steel, and the new composite—has been added. The initial preparation of working drawings is also new in Chapter 7, which covers the established game plan for the preparation of working drawings. Part II, "Document Evolution," includes Chapters 8 through 16 and bridges the gap between theory and practice. These chapters teach the student to prepare site plans, foundation plans, floor plans, exterior elevations, building sections, and other vital drawings. Throughout Part II, the ability to communicate general design ideas and concepts through specific working drawings is emphasized and reinforced through practice.

All of these chapters have been updated with new CAD drawings, including Chapter 16, which discusses elevators, lifts, and stairs as linking forms between floors.

Part III comprises five case studies, including the new Madison Steel Building. In total, there will be access to ten case studies, five of which are new. Palos Verdes condominiums, originally in the *Student Manual*, has four variations in design. These newly developed case studies have been interspersed between Chapters 8 and 16, eliminating the duplication that existed in the previous edition.

Information not included in the book will be available to the reader on a web site for review. Although this book was designed as a stand-alone, the combination of the book and the web site will present ten additional case studies. To understand the total sequencing of the case studies, see the charts in Appendix D at the end of this book or on the web site.

A set of working drawings will be evolved, sheet-by-sheet, layer by layer and at the ends of Chapters 8 through 16. Case studies of real projects, found in Chapters 17 through 20, illustrate the evolution of working drawings from the design concept through the finished construction documents for four different buildings:

1. A hypothetical one-story residence, including the development of a datum layer via a computer-generated 3-D model
2. A two-story beach house
3. A four-plex movie theatre
4. A newly developed all-steel building

These four buildings use a variety of building materials—wood, masonry, and steel systems—and consider environmental and human concerns.

Regional differences affect construction methods, and this is one of the most difficult subjects to address. The authors conducted a national survey to illustrate the di-

verse problems faced by different regions in the country. The results of this survey are carefully summarized and included in Appendix A at the back of this book. Case studies have also been selected to show extreme conditions such as wind, rain, earthquake, and snow.

Appropriately, the illustrations program in this book is its outstanding feature. An additional 400 computer-generated drawings and photographs have been added to the existing 900-plus illustrations. All the new drawings were generated using the same skills described in this book.

Just as clothes, toys, furniture, and other products are made in foreign countries, construction documents are often contracted out and produced in other countries. Communication is electronically instantaneous and less expensive in other countries, and thus many architectural firms are taking advantage of this cheaper, faster method of producing construction documents. Therefore, it is important for our CAD training not only to provide and equip our drafters with information and skills that will make them more competitive with overseas drafters, but also to train our drafters so that they cannot be replaced by those overseas because they produce a better product. It is for this reason that the information contained in this book becomes the critical foundation on which CAD skills can be built. To this end, we have included, in Appendix D, a chart based on CAD standards that can enable an architectural technician or student to set up layers with the proper standards to produce a set of working drawings.

ACKNOWLEDGMENTS

We would like to acknowledge the contribution of the many people who worked on the original manuscript, the second edition, and this third edition of *The Professional Practice of Architectural Working Drawings.*

The two main contributors for the first edition were Marilyn Smith, coordinator and administrative assistant, and Louis Toledo, coordinator of all the hand-drafted illustrations and documents. In addition, Vince Toyama and Gregory Hadden developed additional freehand sketches and case studies; Nancy Nishi was responsible for some of the detailed and tedious checking and typing; and Mark Wakita organized the research questionnaire. Andrea Wakita assisted in the initial proposal and was the resource for research and permissions; William Boggs was responsible for all aerial photography, and Georgia Linde for the preliminary manuscript editing and typing of the original Chapters 3 and 19. Thanks to Art Galvan for coordinating the drafting of all the newly developed images, especially the entire Ryan Residence; Huey Lim, our project manager and coordinator of the artwork and manuscript; Koya Kameshima for photography and specialty/pictorial drawings; Masaya Okada for translating all design drawings and providing us with images to be used in addressing requirements of the Americans with Disabilities ACT (ADA); John Kanounji, who coordinated work between the student guide and the main text; and Edith Martinez, layout drafter for details and charts.

We would like to acknowledge the contributions of several people to the third edition, two in particular: Steve Fuchs Jr. was the coordinator and drafter for the more than 400 new illustrations developed through CAD, and Joan Chappell was the coordinator and administrative assistant for the entire manuscript both new and revised. We also acknowledge the behind-the-scenes work of Cherrella Chumley, Patricia Castillo, Karla Avila, and Jasmine Molano, who were responsible for the reproduction, manuscript/photo sorting, and countless other tasks necessary in the preparation of a book of this type.

Special thanks to Judy Joseph, our original editor; to Amanda Miller, second edition editor; and to Margaret Cummins, third edition editor, for helping us through the difficult world of electronics via computers.

We are sincerely grateful to the academic reviewers who commented on our manuscript during the course of its development.

Reviewers

J. Sam Arnett, *Pitt Community College*
George T. Balich, *Wentworth Institute of Technology*
Robert J. Berry, *Wentworth Institute of Technology*
James Cates, *Brevard Community College*
Paul J. Chase, Chicago, Illinois
A. W. Claussen Jr., *New River Community College*
Frank Corso Jr., *Illinois Central College*
George E. Coughenoyr, *Erie Community College*
Charles W. Dennis, *Diablo Valley College*
Rushia Fellows, *Arizona State University*
L. J. Franceschina, *City College of San Francisco*
Leonard G. Haeger, Santa Barbara, California
Fred Hassaouna, F.I.A.L., A.I.A., A.I.P., *Saddleback Community College District*
Judith B. Hawk, *Northern Virginia Community College*
Donald A. Hinshaw, *Arizona State University*
Dan Houghtaling, *Delaware Technical and Community College*
William A. Kelly, *Los Angeles Trade-Technical College*

PART

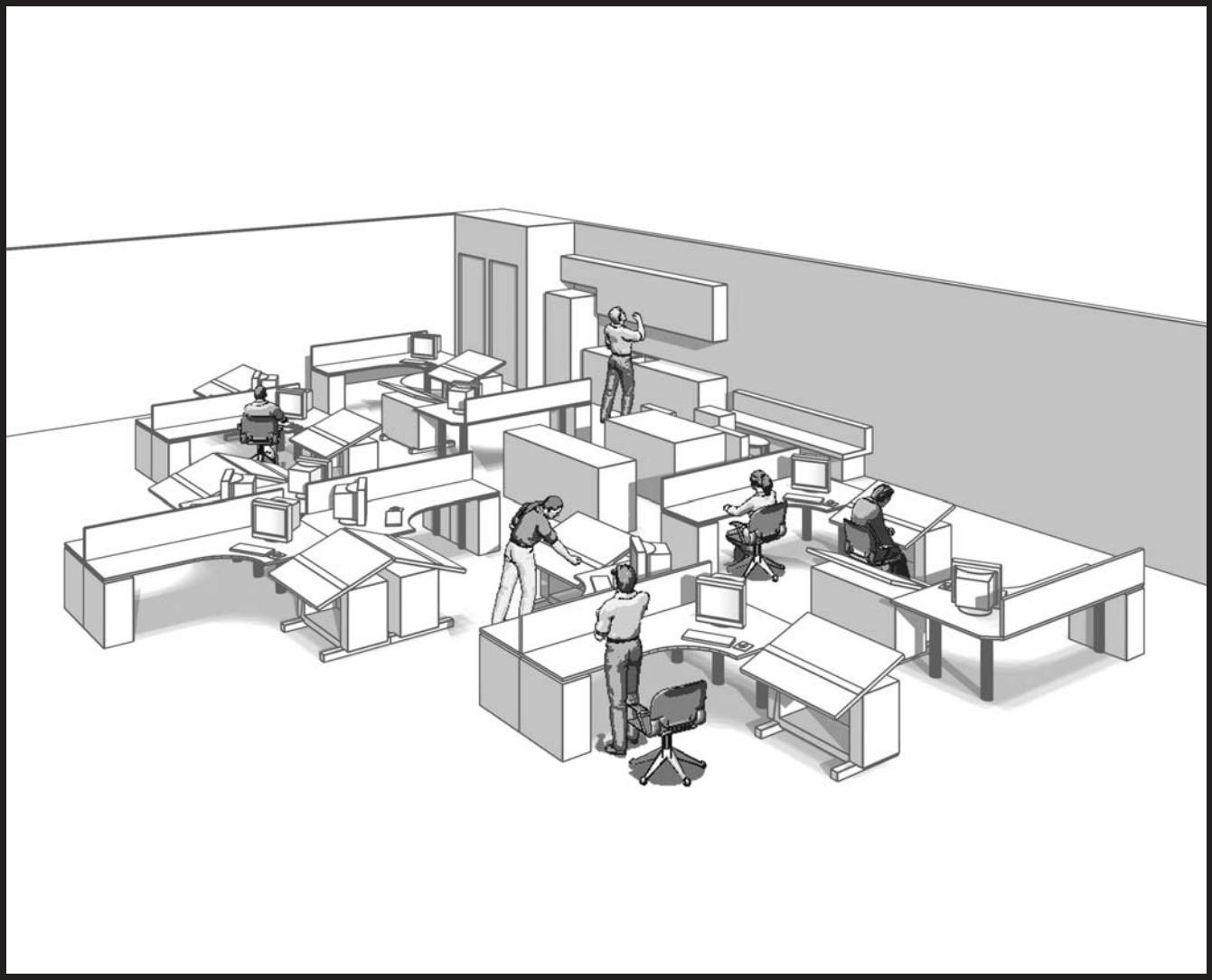
I

Professional Foundations

chapter

1

THE OFFICE



The physical plant of the architectural office has begun to take on a new look. Rows and rows of drafting tables and cubicles are being replaced with mobile stations, giving an entirely new appearance to the work environment. Mobile stations can be reconfigured to the specific needs of a project. The stations can be positioned and repositioned by teams of CAD drafters and designers as the size of a project ebbs and flows. The center for this type of production room may be a conversation area similar to the living room area found in a residence. Here designers and drafters can discuss projects in a relaxed atmosphere. Rather than isolating drafters into small cubicles, as was the case from the 1960s through the 1980s, offices are now beginning to have an open look and feel. The use of low partitions enables the designers and CAD drafters to have eye contact while communicating across the room via computer. Computers are also being networked so that office managers can stay in touch and watch the progress on various projects. For example, if three or more drafters are working on a single project, the information on their individual computers can constantly be upgraded with the latest information as it becomes available. A change in the position of a window on a floor plan will be seen immediately on the different computers where the exterior elevation is being drawn.

Architecture is a small crafts industry in which most offices employ three to eight people. A home office may also be part of the office structure. A single drafter may be hired by two or more firms, and the office then becomes a docking station for the electronic information, such as for construction documents. Because digital images can be rapidly moved electronically, one does not need to live in a city or country to send documents across the world. A suggested office layout is illustrated in Figure 1.1.

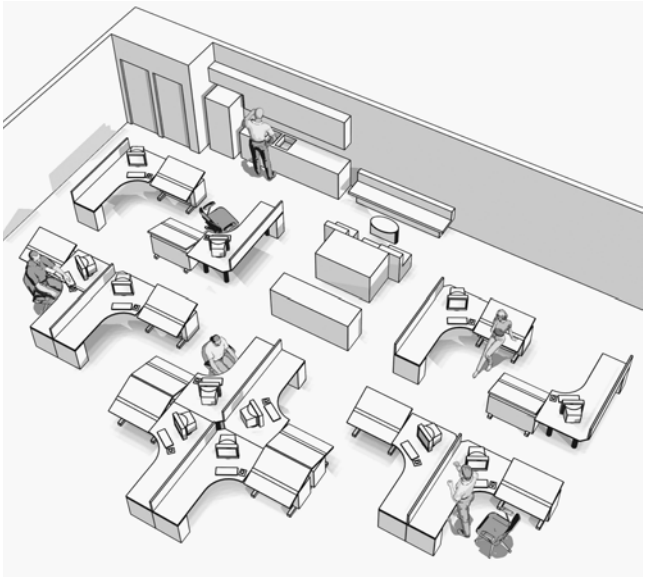


Figure 1.1 Suggested office workstations.

OFFICE PRACTICE AND HOW IT MAY BE STRUCTURED

How an architectural firm is structured and the office practices it employs depends on the magnitude and type of its projects, the number of personnel, and the philosophies the architects use in their approach to office practice procedures. Normally, the architect or architects are the owners and/or principals of the practice.

In general, an architectural office can be separated into three main departments: the administration department, the design department, and the production department.

The administration department handles all communications between the architectural firm and its clients on items such as contracts, fee schedules billing for services, and the like. This department includes all secretarial duties, such as all written correspondence, payment of operating costs, accounting procedures, paying salaries, and maintaining records for all the projects relative to their individual costs and procedures. The principal or principals oversee this department in addition to their other duties.

Design Department

The design department is normally headed by either a principal architect and/or an associate architect. This person or persons meets with the client to determine the requirements of a project, the economics of the project, and the anticipated time frame for completing the construction documents. These initial concerns determine the program for the project. The head or heads of this department delegate various work phases of a project to other staff members. The number of staff members depends on the size of the practice and the magnitude of the projects. Staff members may be designated to teams or groups relative to their expertise for specific projects. A team takes a project from the initial design concept stage, through all the revisions and other stages, to the completed working drawings and specifications. These stages may include model building, renderings, coordination between all consulting engineers to meet their individual job requirements, job billing, and reproduction responsibilities. The leader of a project and of the design team staff is designated as the project architect. His or her responsibilities are to develop a game plan for a specific project that will include the following:

1. Design studies and philosophy
2. Initial structural considerations
3. Exterior and interior materials
4. Municipality and building code requirements

5. If applicable, architectural committee reviews
6. Building equipment requirements
7. Manufacturing resources
8. Selection of required engineering consultants such as; soils/geology, structural, mechanical, etc.
9. Planned man-hours, time sheets and billing dates
10. Office standards relative to the representation of items on the working drawings such as; symbols, wall delineations, and other graphic depictions

Production Department

The production department, while supervised by a project architect, prepares all the phases for a set of completed working drawings. Working drawings may be produced by senior draftpersons, intermediate draftpersons, or junior draftpersons. These staff members and the project architect or job captain work as a team to make the transition from the approved preliminary drawings to the implementation and completion of the working drawings. The transition from the approved preliminary drawings to the development of the working drawings is elaborated in Chapter 6 of this book. Other chapters provide step-by-step procedures on how different sections of the working drawings are developed: the site and grading plan, foundation plan, floor plan, building sections, exterior elevations, roof and framing plans, interior elevations, architectural details and schedules. During the process and completion of the various sections, the project architect and/or job captain constantly review the drawings for clarity, accuracy, craftsmanship of detailing, and to see that the drawings reflect all current revisions. These drawings are either created with the use of a computer-aided drafting (CAD) system or are drawn manually using conventional instruments. A suggested organizational chart for the practice of architecture is depicted in Figure 1.2.

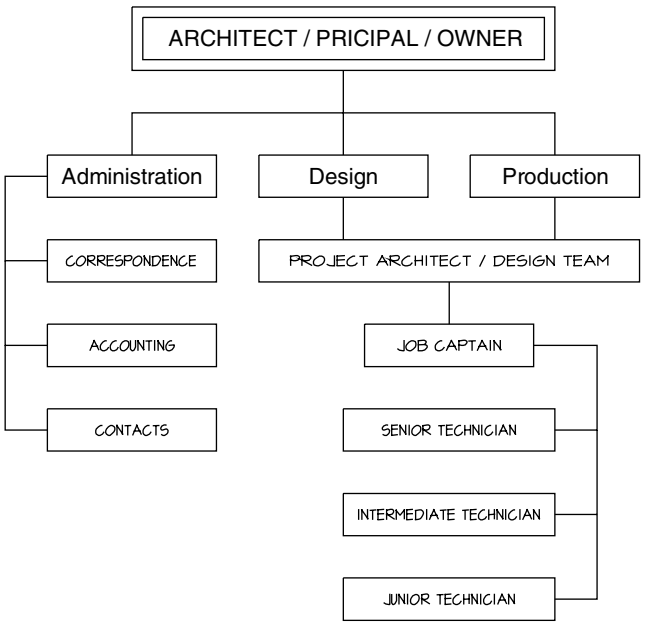


Figure 1.2 Suggested office organizational chart.

RESOURCES

To accommodate all the equipment that is required for a structure, such as plumbing, hardware, finishes, and so forth, it is necessary to have access to the various manufacturing resources for specific products. The most widely used product information source is the *Sweet's Catalog File*. This file is provided in a set of volumes that allow architects and engineers to select the equipment necessary for the function of a building. Such equipment may be available from various manufacturers of conveying systems, window and doors, and the like. Information on the various products is now contained on CD-ROMs, which are easier to manipulate than the larger volumes. There are a number of electronic files that can be obtained. The CDs are based on the *Uniform Construction Index*, used widely in the construction industry. These particular systems use the following sixteen major divisions:

1. General data
2. Site work
3. Concrete
4. Masonry
5. Metals
6. Wood and plastics
7. Thermal and moisture protection
8. Doors and windows
9. Finishes
10. Specialties
11. Equipment
12. Furnishing
13. Special construction
14. Conveying systems
15. Mechanical
16. Electrical

Research via the Computer

Almost every large manufacturer has a web site that you can visit via the Internet. One can now research anything from hardware to framing anchors, engineered lumber products to composite building products. Research for building products is done in the same fashion as research for a term paper. The scope of such research can be worldwide. You are limited only by your ability to navigate through the sea of information and your ability to retrieve the necessary information that will satisfy and enhance the completion of the working drawings.

Most manufacturers also provide the architect with a video explaining a product, its specifications, and installation. Digital drawings can also be obtained, making it unnecessary to draw configurations for products such as window sections, stairs, and the like.

Manufacturers' Literature

A wealth of product information is available directly from manufacturers in the form of brochures, pamphlets, catalogs, manuals, and hardbound books. Actual samples of their products may also be obtained. The information available can include the following:

1. Advantages of a particular product over others
2. How the system works or is assembled
3. Necessary engineering
4. Detailed drawings
5. Special design features
6. Colors, textures, and patterns
7. Safety tests
8. Dimensioning
9. Installation procedures

Other Reference Sources

Retail sources such as major book publishers produce architectural reference books. Many art supply and drafting supply stores also carry reference materials. Public libraries contain a variety of professional reference materials—books, journals, and magazines. Colleges and universities offering architecture courses have architectural resource materials. These may include a broad general coverage of such areas as architectural drafting, graphics, engineering, and design principles. An example of a highly technical resource is the *AIA Architectural Graphics Standards* published by John Wiley & Sons. This book includes the maximum, minimum, and average sizes for a variety of items and contains such diverse information as the size of a baseball diamond or a bowling alley, the dimensions of most musical instruments, and the standard sizes for most major kitchen utensils and appliances. This book is found in almost all architectural offices.

Guides and Indexes

Two invaluable general book indexes are the *Subject Guide to Books in Print* (author and title volumes) and the *Reader's Guide to Periodical Literature*. All major bookstores carry these annual reference books. The *Reader's Guide to Periodical Literature* is excellent for locating magazine articles on specific building types, new building techniques, and works of specific architects. Four additional sources of architectural information are the *Art Index*, *Applied Science and Technology*, *The Humanities Index,* and the *Social Science Index*. These are available in most college and university libraries and in major public libraries.

PROFESSIONAL ORGANIZATIONS

Professional organizations can be an asset to the business performance and office functions of an architectural firm. The American Institute of Architects (AIA) is an example of a professional organization that will provide members with recommended documents, including client and architect contractual agreements, client and contractor agreements, and many others. The institution also provides recommended guidelines relative to fee schedules and disbursements, construction document facets, building specifications, and construction observation procedures and documentation.

Ethical procedures and office practice methods are recommended and defined as part of the many documents that are available from the American Institute of Architects.

It is recommended that associate architects and employees at the various technical levels become involved with a professional organization for a number of reasons, including being made aware of current technical information and activities within the profession of architect. The AIA also offers programs and directions for those in an internship phase of their careers. Student associate member programs are available through the AIA which provide an overall view of the architectural profession.

Other professional organizations for students of architecture can be found in their respective colleges and universities.

ARCHITECT/CLIENT RELATIONSHIP

The relationship between the architect and the client, and the procedures for building a project, will vary among architectural offices as different architectural philosophies may be practiced.

In general, the architect/client relationship for a specific building project and the necessary responsibilities and procedures to accomplish the goals of the project will be initiated with the selection of the architect. After the architect is selected, the architect and the client enter into a contract, which defines the services to be performed and the responsibilities of the architect and the client. In many states it is a requirement that the architect use a written contract when providing professional services.

After the contractual agreement is signed and a retainer fee is given, the architect reviews the building site and confers with the client to determine the goals of the

building project. Upon establishing the project's goals, there will be meetings with the governing agencies, such as the planning department, the building department, and architectural committees. The primary goal of the architectural team will be to initiate the preliminary planning and design phases.

In most architectural contract agreements, there are provisions for the architect and the consulting engineers to observe construction of the project during the building stage.

Construction Observation

When the construction firm has been selected and construction has commenced, the architect and consulting engineers, according to their agreement in the contract, observe the various phases of construction. These periodic observations generally correspond to the construction phases, such as during construction of the foundation, framing, and so forth. Following their observations, the architect and consulting engineers provide written reports to the client and contractor describing their observations, along with any recommendations or alterations they deem necessary for success of the project.

Preliminary Designs and Reviews

The next step in the architect/client relationship is the architect's presentation of the preliminary planning and design for the project. After the client's initial review of the project's planning and design, there may be some revisions and alterations to the design. In this case, the preliminary drawings are revised and presented again to the client for his or her approval. After the approval of the preliminary design by the client, the architect consults and presents the preliminary drawings to the various governing agencies for their review and comments. Any revisions and alterations that may be required by any one of the agencies are executed and again reviewed by the client for his or her approval. In many offices the preliminary drawings are often used to estimate the initial construction costs that will be submitted for review and approval by the client.

In the preliminary planning and design phase, a conceptual site plan and floor plan of the building areas are reviewed for the building orientation and the preservation of existing landscaping elements such as trees, topography, and other site conditions. An example of a conceptual site and building plan is illustrated in Figure 1.3. The

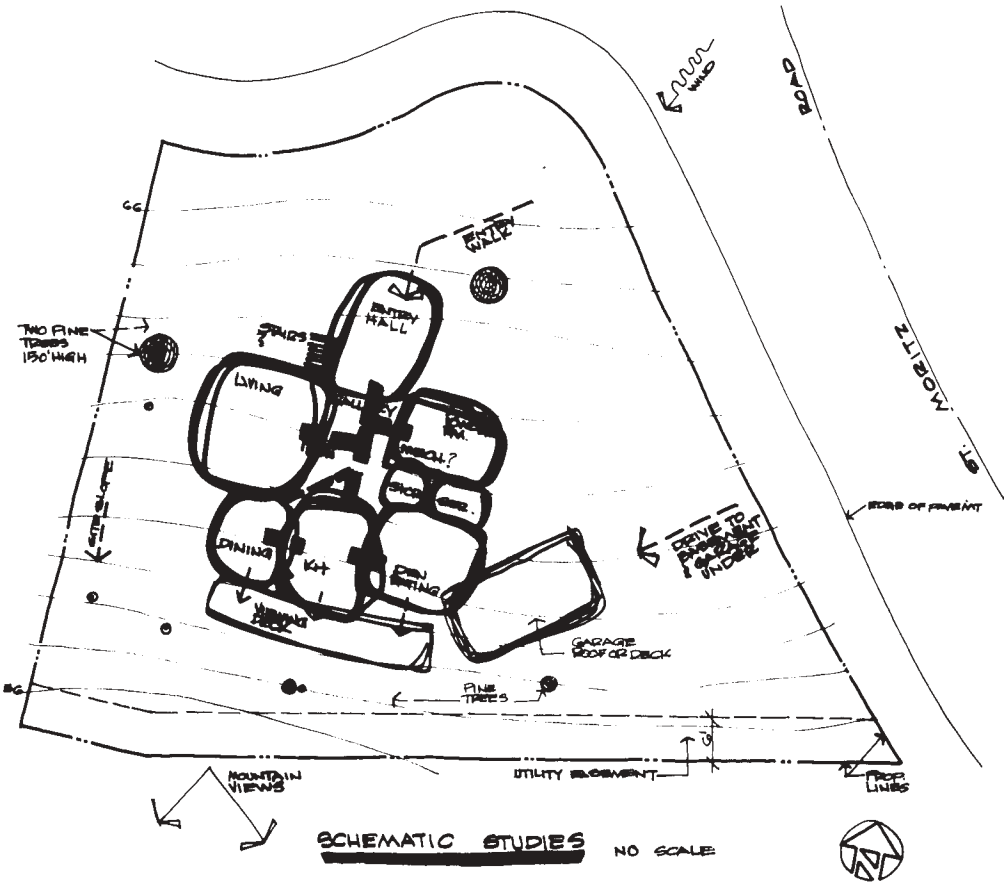


Figure 1.3 Schematic studies.

client for this project desires to build a three-bedroom residence for a young family. The site is located in a mountain area that is subject to heavy snow conditions. Two large pine trees are on the site, which are to be retained.

Besides the large pine trees, the mountain views, wind direction, and the most feasible automobile access to the site are considered, and a schematic study is presented. From this initial schematic study a preliminary floor plan is established, which shows the room orientations and their relationships to one another. This preliminary drawing is depicted in Figure 1.4. A second floor level preliminary plan is studied as it relates to the first floor plan and the room orientation as shown in Figure 1.5. Finally, a basement floor plan is designed to facilitate the use of an artist's studio and a cabinet workshop. This preliminary study is illustrated in Figure 1.6. The studies of the exterior elevations evolved utilizing an insulated aluminum roof material, with a steep pitched roof, and exterior walls of wood siding. The unusual shape of the residence required studies of the roof plan for geometric solutions. As developed from these studies, a roof plan is shown in Figure 1.7. After the client has approved the preliminary floor plans, the exterior elevations for the North and West are presented in preliminary form to the client for approval, and to the governmental agencies for their required approvals. The North and West elevations are depicted in Figures 1.8 and 1.9. These preliminary drawings and designs are but examples of the architect's studies that may be presented to the client for his or her approval prior to implementation of the working drawings.

IMPLEMENTATION OF THE WORKING DRAWINGS

After approval of the preliminary designs and planning for a project by the client and governing agencies, the architect's office initiates the working drawing phase for the construction of the project.

During the working drawing phase a team of architects consult with the engineers required on a specific project.

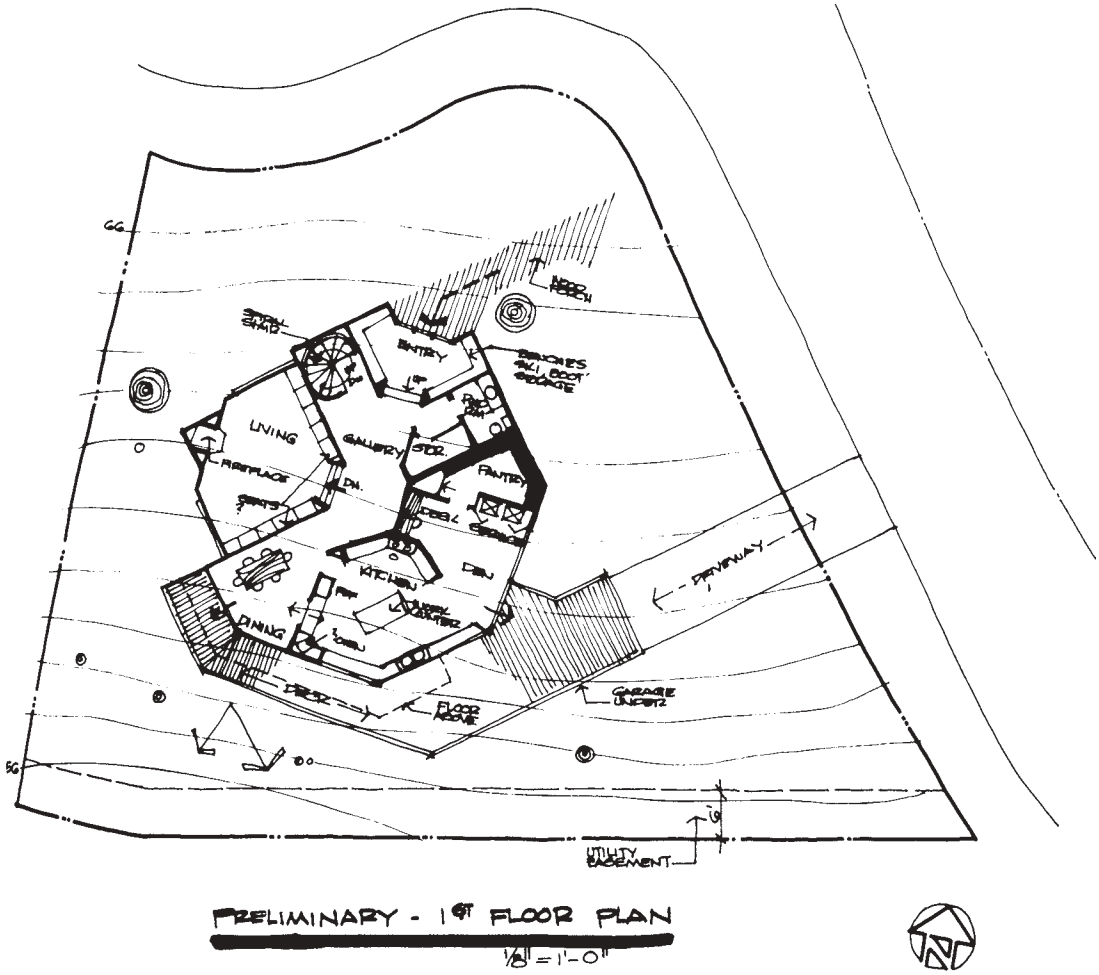


Figure 1.4 Preliminary—first floor plan.

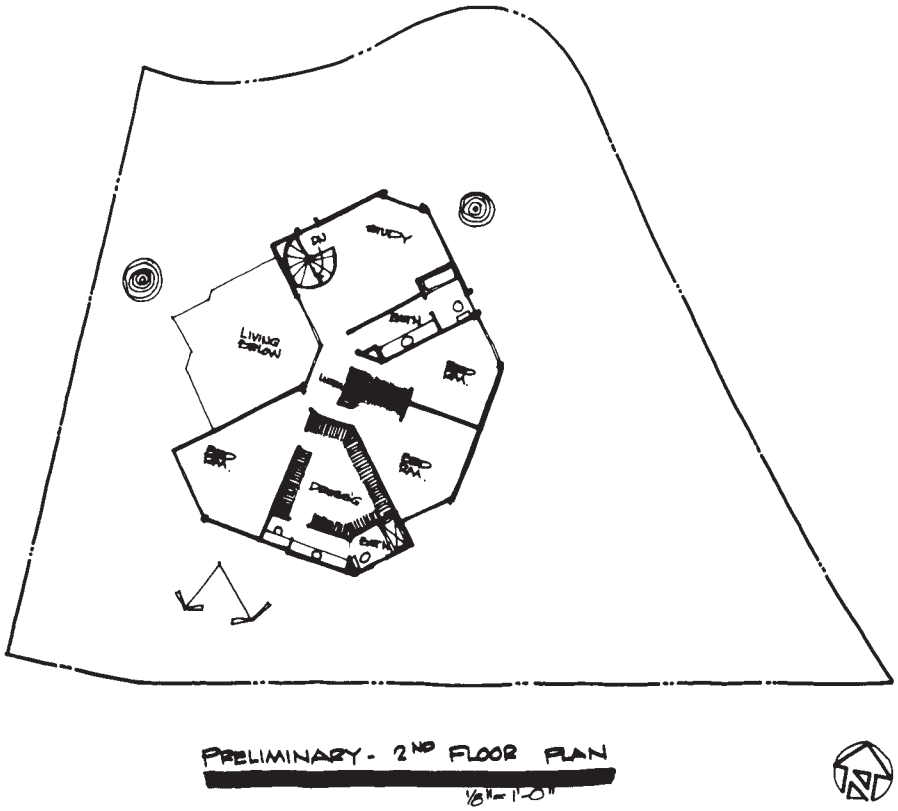


Figure 1.5 Preliminary—second floor plan.

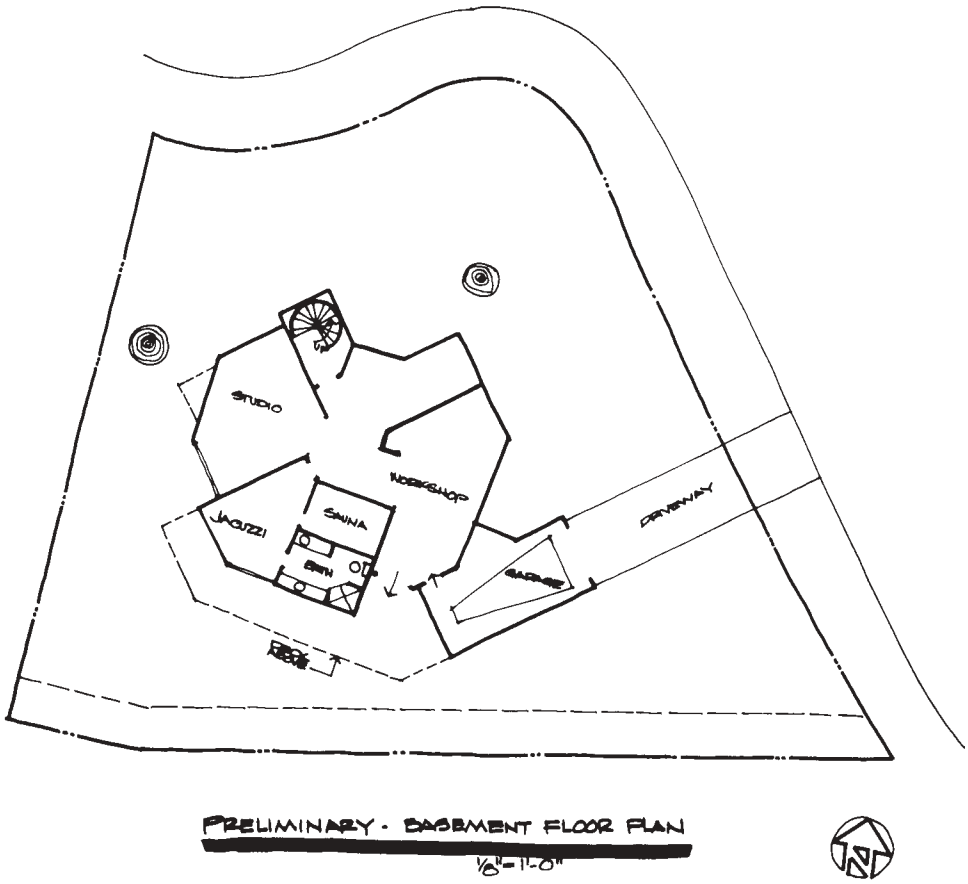


Figure 1.6 Preliminary—basement floor plan.

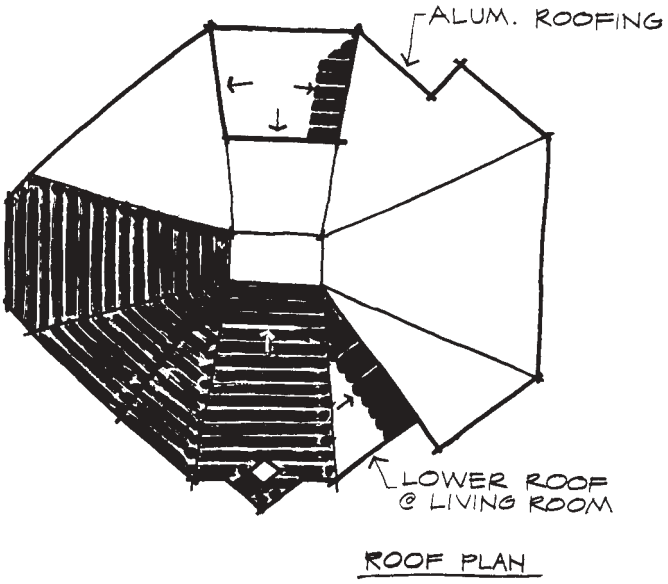


Figure 1.7 Roof plan—conceptual design.

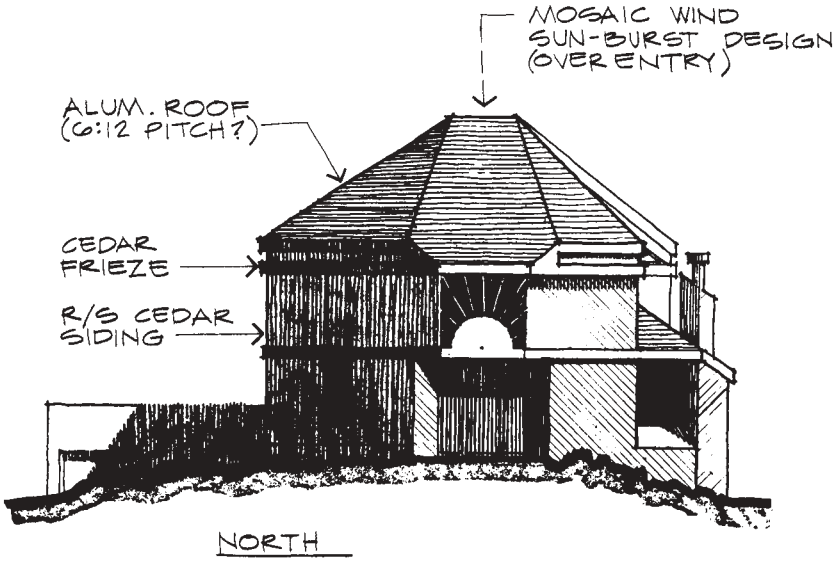


Figure 1.8 North exterior conceptual design.

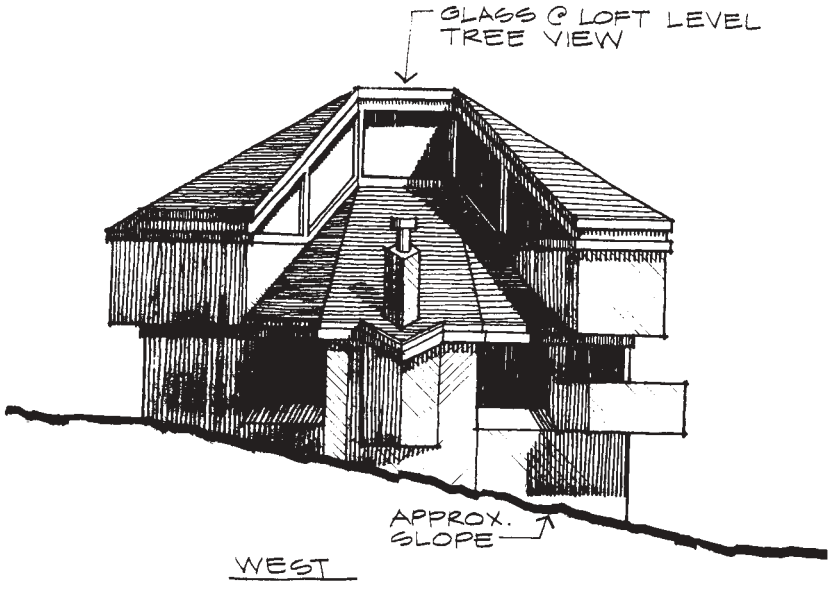


Figure 1.9 West exterior conceptual design.

Consulting engineers may be employed directly by the architect, or they may have their own private practice. These consultants may include a soils and geological engineer, a structural engineer, a mechanical engineer, an electrical engineer, and a civil engineer. Other consultants may include a landscape architect and a cost estimator. Periodic conferences with the client are recommended during this phase in order to attain approvals on the various phases of the working drawings. These phases or stages may include lighting and electrical designs, interior cabinetry, wall designs, and many other features that may necessitate review and approval by the client. If these drawings are being developed by use of a CAD system, refer to Chapter 3 for recommended procedures.

Materials and Specifications

There will be numerous conferences between the architect and the client during the working drawing phase to select and determine items such as exterior and interior wall finishes, flooring, plumbing fixtures, hardware design, type of masonry, roofing materials, and so on. During these conferences, the selection of building equipment and systems are also reviewed and determined. The equipment selection may include such items as types of windows and doors and the manufacturer, the elevator type and manufacturer, the mechanical system, electrical fixtures, and so on. Refer to Chapter 6 for related information on the aforementioned items.

Finalization of the Working Drawings and Specifications

Upon completion of the working drawings and specifications, which are now termed construction documents, the architect and/or client may submit the construction documents to financing institutions for building loans, to various construction firms for building cost proposals, and to governing agencies for their final approvals. Finally, the architectural firm will be responsible for submitting the construction documents to the local building department for its approval to obtain the required building permits.

At the completion of the project, the architect and his or her consultants make a final inspection of the construction of the building and prepare what is termed a "punch list." This punch list is in written form and includes graphics indicating to the client and construction firm any revisions, reports, or alterations they deem pertinent and reasonable for a successful building project. After the construction firm makes the revisions, the architect and the consultants again inspect the revisions for approval. If acceptable, a final notice of approval is sent to the client and the construction firm.

BUILDING

Building Codes

The purpose of building codes is to safeguard life, health, and the public welfare. Building codes are continually being revised and incorporating additional regulations based on tests or conditions caused by catastrophic events, such as hurricanes, earthquakes, and fires. In most cases, the governing building codes are similar in organization and context. The following building code examples and portions are derived from the current edition of the *Uniform Building Code*.

Building Code Divisions Primarily, the *Uniform Building Code* is divided into eleven parts with specific chapters and sections incorporated into the various parts. The various parts are as follows:

Part I	Administration
Part II	Definitions and Abbreviations
Part III	Requirements Based on Occupancy
Part IV	Requirements Based on Types of Construction
Part V	Engineering Regulations—Quality and Design of the Materials of Construction
Part VI	Detailed Regulations
Part VII	Fire-Resistive Standards for Fire Protection
Part VIII	Regulations for Use of Public Streets and Projections over Public Property
Part IX	Wall and Ceiling Coverings
Part X	Special Subjects
Part XI	Uniform Building Code Standards

The requirements of various agencies and codes are of paramount influence in the design and detailing of today's structures. There are a great number of codes that govern and regulate the many elements that are integrated into the construction of a building. The major codes that are used in the design and detailing of buildings are the building code, mechanical code, electrical code, fire code, energy code, and accessibility design criteria for persons with disabilities.

Procedures for Use of the Building Codes There are a number of governing building code requirements that dictate the architectural designs an architect or designer will incorporate in developing a design for a specific structure. For example, to establish the design program for a proposed two-story building having a floor area of 10,000 square feet per floor, it will be necessary to review the governing building code to determine the various requirements that dictate a major portion of the design criteria. The following are the primary steps used in most building codes to determine the classification and requirements for a specific structure.

STEP I. *Building use and occupancy.* The first step is to classify the building use and to determine the occupancy group that satisfies the use of the building. When the occupancy classification has been determined, the building is assigned a group designation letter. An example of a table found in the *Uniform Building Code*, which determines the description of the occupancy and the group it falls under, is illustrated in Figure 1.10. Note that the proposed office building is designated in the category of group B.

STEP II. *Fire-rated wall assemblies.* As indicated in Figure 1.11, all the walls of the proposed office building have to be constructed so as to meet the requirements of one-hour fire-rated assemblies acceptable by the governing code. Most codes provide a chapter on acceptable fire-resistive standards for assemblies, so that the architect or designer is able to select an assembly that satisfies his or her specific condition. An example of the assembly of a one-hour fire-rated 2″ × 4″ wood stud partition is given in Figure 1.14, item 16-1.4. This wall assembly will now be part of the building design program.

STEP III. *Building location on the site.* The location of the building on the site and the clearances to the property lines and other structures on the site determine the fire-resistant construction of the exterior walls. The openings are based on the distances from the property lines and other structures. Figure 1.11 illustrates the required fire-resistant construction of the exterior walls and openings in the walls based on the distances to the property lines.

STEP IV. *Allowable floor areas.* The next step is to determine the proposed and allowable floor areas of the building based on the occupancy group and the type of construction. Figure 1.12 indicates the type of construction required based on the allowable floor area for one-story buildings. For multistory buildings, the architect will review another section of the code.

STEP V. *Height and the number of stories or floors in the building.* The architect computes the maximum height of the building and determines the number of stories and/or floors. The maximum number of stories and the height of the building are determined by the building occupancy and the type of construction.

TABLE NO. 5-A—WALL AND OPENING PROTECTION OF OCCUPANCIES BASED ON LOCATION ON PROPERTY
Types II One-Hour, II-N and V Construction: For exterior wall and opening protection of Types II One-hour, II-N and V buildings, see table below and Sections 504, 709, 1903 and 2203. This table does not apply to Types I, II-F.R., III and IV construction, see Sections 1803, 1903, 2003 and 2103.

GROUP	DESCRIPTION OF OCCUPANCY	FIRE RESISTANCE OF EXTERIOR WALLS	OPENINGS IN EXTERIOR WALLS[1]
A See also Section 602	1— Any assembly building or portion of a building with a legitimate stage and an occupant load of 1,000 or more	Not applicable (See Sections 602 and 603)	
	2— An building or portion of a building having an assembly room with an occupant load of less than 1,000 and a legitimate stage	2 hours less than 10 feet, 1 hour less than 40 feet	Not permitted less than 5 feet Protected less than 10 feet
	2.1— Any building or portion of a building having an assembly room with an occupant load of 300 or more without a legitimate stage, including such buildings used for educational purposes and not classed as Group E or Group B, Division 2 Occupancy		
	3— Any building or portion of a building having an assembly room with an occupant load of less than 300 without a legitimate stage, including such buildings used for educational purposes and not classed as a Group E or Group B, Division 2 Occupancy	2 hours less than 5 feet, 1 hour less than 20 feet	Not permitted less than 5 feet Protected less than 10 feet
	4— Stadiums, reviewing stands and amusement park structures not included with other Group A Occupancies	1 hour less than 10 feet	Protected less than 10 feet
B See also Section 702	1— Repair garages where work is limited to exchange of parts and maintenance requiring no open flame, welding, or use of Class I, II or III-A liquids, motor vehicle fuel-dispensing stations and parking garages not classified as Group B, Division 3 open parking garages or Group M, Division I private garages	1 hour less than 20 feet	Not permitted less than 5 feet Protected less than 10 feet
	2— Drinking and dining establishments having an occupant load of less than 50, wholesale and retail stores, office buildings, printing plants, police and fire stations, factories and workshops using material not highly flammable or combustible, storage and sales rooms for combustible goods, paint stores without bulk handling Buildings or portions of buildings having rooms used for educational purposes, beyond the 12th grade, with less than 50 occupants in any room		

Figure 1.10 Occupancy description.

TABLE NO. 5-A—Continued
TYPES II ONE-HOUR, II-N AND V ONLY

GROUP	DESCRIPTION OF OCCUPANCY	FIRE RESISTANCE OF EXTERIOR WALLS	OPENINGS IN EXTERIOR WALLS[1]
B (Cont.)	3— Aircraft hangars where no repair work is done except exchange of parts and maintenance requiring no open flame, welding, or the use of Class I or II liquids Open parking garages (For requirements, see Section 709) Helistops	1 hour less than 20 feet	Not permitted less than 5 feet Protected less than 20 feet
	4— Ice plants, power plants, pumping plants, cold storage and creameries Factories and workshops using noncombustible and nonexplosive material Storage and sales rooms of noncombustible and nonexplosive materials that are not packaged or crated in or supported by combustible material	1 hour less than 5 feet	Not permitted less than 5 feet
E See also Section 802	1— Any building used for educational purposes through the 12th grade by 50 or more persons for more than 12 hours per week or four hours in any one day	2 hours less than 5 feet, 1 hour less than 10 feet[2]	Not permitted less than 5 feet Protected less than 10 feet[2]
	2— Any building used for educational purposes through the 12th grade by less than 50 persons for more than 12 hours per week or four hours in any one day		
	3— Any building or portion thereof used for day-care purposes for more than six persons		
H	See Table No. 9-C		
I See also Section 1002	1.1— Nurseries for the full-time care of children under the age of six (each accommodating more than five persons) Hospitals, sanitariums, nursing homes with nonambulatory patients similar buildings (each accommodating more than five persons)	2 hours less than 5 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 10 feet
	1.2— Health-care centers for ambulatory patients receiving outpatient medical care which may render the patient incapable of unassisted self-preservation (each tenant space accommodating more than five such patients)		
	2— Nursing homes for ambulatory patients, homes for children six years of age of over (each accommodating more than five persons)	1 hour	Not permitted less than 5 feet Protected less than 10 feet
	3— Mental hospitals, mental sanitariums, jails, prisons, reformatories and buildings where personal liberties of inmates are similarly restrained	2 hours less than 5 feet. 1 hour elsewhere	
M[3] See also Section 1102	1— Private garages, carports, sheds and agricultural buildings	1 hour less than 3 feet (or may be protected on the exterior with materials approved for 1-hour fire-resistive construction)	Not permitted less than 3 feet
	2— Fences over 6 feet high, tanks and towers	Not regulated for fire resistance	
R See also Section 1202	1— Hotels and apartment houses Congregate residences (each accommodating more than 10 persons)	1 hour less than 5 feet	Not permitted less than 5 feet
	3— Dwellings and lodging houses, congregate residences (each accommodating 10 persons or less)	1 hour less than 3 feet	Not permitted less than 3 feet

[1]Openings shall be protected by a fire assembly having at least a three-fourths-hour fire-protection rating.
[2]Group E, Divisions 2 and 3 Occupancies having an occupant load of not more than 20 may have exterior wall and opening protection as required for Group R, Division 3 Occupancies.
[3]For agricultural buildings, see Appendix Chapter 11.
NOTES: (1) See Section 504 for types of walls affected and requirements covering percentage of openings permitted in exterior walls.
(2) For additional restrictions, see chapters under Occupancy and Types of Construction
(3) For walls facing yards and public ways, see Part IV.

Figure 1.10 Occupancy description *(continued)*.

TABLE NO. 17-A—TYPES OF CONSTRUCTION—FIRE-RESISTIVE REQUIREMENTS (In Hours)
For details see chapters under Occupancy and Types of Construction and for exceptions see Section 1705.

	TYPE I	TYPE II			TYPE III		TYPE IV	TYPE V	
	NONCOMBUSTIBLE				COMBUSTIBLE				
BUILDING ELEMENT	FIRE-RESISTIVE	FIRE-RESISTIVE	1-HR.	N	1-HR.	N	H.T.	1-HR.	N
1. Exterior Bearing Walls	4 Sec. 1803 (a)	4 1903 (a)	1	N	4 2003 (a)	4 2003 (a)	4 2103 (a)	1	N
2. Interior Bearing Walls	3	2	1	N	1	N	1	1	N
3. Exterior Nonbearing Walls	4 Sec. 1803 (a)	4 1903 (a)	1 1903 (a)	N	4 2003 (a)	4 2003 (a)	4 2103 (a)	1	N
4. Structural Frame[1]	3	2	1	N	1	N	1 or H.T.	1	N
5. Partitions—Permanent	1[2]	1[2]	1[2]	N	1	N	1 or H.T.	1	N
6. Shaft Enclsoures[3]	2	2	1	1	1	1	1	1	1
7. Floors-Ceilings/Floors	2	2	1	N	1	N	H.T.	1	N
8. Roofs-Ceilings/Roofs	2 Sec. 1806	1 1906	1 1906	N	1	N	H.T.	1	N
9. Exterior Doors and Windows	Sec. 1803 (b)	1903 (b)	1903 (b)	1903 (b)	2003 (b)	2003 (b)	2103 (b)	2203	2203
10. Stairway Construction	Sec. 1805	1905	1905	1905	2004	2004	2104	2204	2204

N—No general requirements for fire resistance. H.T.—Heavy Timber.
[1]Structural frame elements in an exterior wall that is located where openings are not permitted or where protection for openings is required shall be protected against external fire exposure as required for exterior bearing walls or the structural frame, whichever is greater.
[2]Fire-retardant-treated wood (see Section 407) may be used in the assembly, provided fire-resistance requirements are maintained. See Sections 1801 and 1901, respectively.
[3]For special provisions, see Sections 1706, 706, 906.

Figure 1.11 Fire-resistive requirements.

TABLE NO. 5-C—BASIC ALLOWABLE FLOOR AREA FOR BUILDINGS ONE STORY IN HEIGHT[1] (in square feet)

	TYPES OF CONSTRUCTION								
	I	II			III		IV	V	
OCCUPANCY	F.R.	F.R.	ONE-HOUR	N	ONE-HOUR	N	H.T.	ONE-HOUR	N
A-1	Unlimited	29,900				Not Permitted			
A-2-2.1[2]	Unlimited	29,900	13,500	Not Permitted	13,500	Not Permitted	13,500	10,500	Not Permitted
A-3-4[2]	Unlimited	29,900	13,500	9,100	13,500	9,100	13,500	10,500	6,000
B-1-2-3[3]	Unlimited	39,900	18,000	12,000	18,000	12,000	18,000	14,000	8,000
B-4	Unlimited	59,900	27,000	18,000	27,000	18,000	27,000	21,000	12,000
E-1-2-3	Unlimited	45,200	20,200	13,500	20,200	13,500	20,200	15,700	9,100
H-1	15,000	12,400	5,600	3,700	Not Permitted				
H-2[4]	15,000	12,400	5,600	3,700	5,600	3,700	5,600	4,400	2,500
H-3-4-5[4]	Unlimited	24,800	11,200	7,500	11,200	7,500	11,200	8,800	5,100
H-6-7	Unlimited	39,900	18,000	12,000	18,000	12,000	18,000	14,000	8,000
I-1.1-1.2-2	Unlimited	15,100	6,800	Not Permitted	6,800	Not Permitted	6,800	5,200	Not Permitted
I-3	Unlimited	15,100	Not Permitted[5]						
M[6]	See Chapter 11								
R-1	Unlimited	29,900	13,500	9,100[7]	13,500	9,100[7]	13,500	10,500	6,000[7]
R-3					Unlimited				

N—No requirements for fire resistance **F.R.**—Fire resistive **H.T.**—Heavy timer
[1]For multistory buildings, see Section 505(b).
[2]For limitations and exceptions, see Section 602.
[3]For open parking garages, see Section 709.
[4]See Section 903.
[5]See Section 1002(b).
[6]For agricultural buildings, see also Appendix Chapter 11.
[7]For limitations and exceptions, see Section 1202(b).
[8]In hospitals and nursing homes, see Section 1002(a) for exception.

Figure 1.12 Allowable types of construction.

TABLE NO. 5-D—MAXIMUM HEIGHT OF BUILDINGS

OCCUPANCY	TYPES OF CONSTRUCTION								
	I	II			III		IV	V	
	F.R.	F.R.	ONE-HOUR	N	ONE-HOUR	N	H.T.	ONE-HOUR	N
	MAXIMUM HEIGHT IN FEET								
	Unlimited	160	65	55	65	55	65	50	40
	MAXIMUM HEIGHT IN FEET								
A-1	Unlimited	4				Not Permitted			
A-2-2.1	Unlimited	4	2	Not Permitted	2	Not Permitted	2	2	Not Permitted
A-3-4[1]	Unlimited	12	2	1	2	1	2	2	1
B-1-2-3[2]	Unlimited	12	4	2	4	2	4	3	2
B-4	Unlimited	12	4	2	4	2	4	3	2
E[3]	Unlimited	4	2	1	2	1	2	2	1
H-1[4]	1	1	1	1			Not Permitted		
H-2[4]	Unlimited	2	1	1	1	1	1	1	1
H-3-4-5[4]	Unlimited	5	2	1	2	1	2	2	1
H-6-7	3	3	3	2	3	2	3	3	1
I-1.1[5]-1.2	Unlimited	3	1	Not Permitted	1	Not Permitted	1	1	Not Permitted
I-2	Unlimited	3	2	Not Permitted	2	Not Permitted	2	2	Not Permitted
I-3	Unlimited	2	Not Permitted[6]						
M[7]	See Chapter 11								
R-1	Unlimited	12	4	2[8]	4	2[8]	4	3	2[8]
R-3	Unlimited	3	3	3	3	3	3	3	3

Figure 1.13 Maximum building heights.

TABLE NO. 43-B—RATED FIRE-RESISTIVE PERIODS FOR VARIOUS WALLS AND PARTITIONS

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE[2]			
			4 Hr.	3 Hr.	2 Hr.	1 Hr.
15. Nonum-bustible Studs—Interior Partition with Gypsum Wallboard Each Side	15-1.3	No. 16 gauge approved nailable metal studs[10] 24" on center with full-length 5/8" Type X gypsum wallboard[7] applied vertically and nailed 7" on center with 6d cement-coated common nails. Approved metal fastener grips used with nails at vertical butt joints along studs.				4 7/8
16. Wood Studs—Interior Partition with Gypsum Wallboard Each Side	16-11[11 16]	2" × 4" wood studs 16" on center wiht two layers of 3/8" regular gypsum wallboard[7] each side. 4d cooler[12] or wallboard[12] nails at 8" on center first layer, 5d cooler[12] or wallboard[12] nails at 8" on center second layer with laminating compound between layers. Joints staggered. First layer aplied full length vertically, second layer applied horizontally or vertically.				5
	16-1.2[11 16]	2" × 4" wood studs 16" on center with two layers 1/2" regular gypsum wallboard[7] applied vertically or horizontally each side, joints staggered. Nail base layer with 5d cooler[12] or wallboard[12] nails at 8" on center, face layer with 8d cooler[12] or wallboard[12] nails at 8" on center.				5 1/2
	16.1.3[11 16]	2" × 4" wood studs 24" on center with 5/8" Type X gypsum wallboard[7] aplied vertically or horizontally nailed with 6d cooler[12] or wallboard[12] nails at 7" on center with end joints on nailing members. Stagger joints each side.				4 3/4
	16-1.4[11]	2" × 4" fire-retardant-treated wood studs spaced 24" on center with one layer of 5/8" thick Type X gypsum wallboard[7] applied with face paper grain (long dimension) paralell to studs. Wallboard attached with 6d cooler[12] or wallboard[12] nails at 7" on center.				

Figure 1.14 Fire-resistive wall assemblies *(continued)*.

TABLE NO. 43-B—RATED FIRE-RESISTIVE PERIODS FOR VARIOUS WALLS AND PARTITIONS

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE[2]			
			4 Hr.	3 Hr.	2 Hr.	1 Hr.
17. Exterior or Interior Walls	17-1.3[11 16]	2″ × 4″ wood studs 16″ on center with 7/8″ exterior cement plaster (measured from the face of studs) on the exterior surface with interior surface treatment as required for interior wood stud partitions in this table. Plaster mix 1:4 for scratch coat and 1.5 for brown coat, by volume, cement to sand.				Varies
	17-1.4	3 5/8″ No. 16 gauge noncombustible studs 16″ on center with 7/8″ exterior cement plaster (measured from the face of the studs) on the exterior surface with interior surface treatment as required for interior, nonbearing, noncombustible stud partitions in this table. Plaster mix 1:4 for scratch coat and 1:5 for brown coat, by volume, cement to sand.				Varies[4]
	17-1.5[16]	2 1/4″ × 3 3/4″ clay face brick with cored holes over 1/2″ gypsum sheathing on exterior surface of 2″ × 4″ wood studs at 16″ on center and two layers 5/8″ Type X gypsum wallboard[7] on interior surface. Sheathing placed horizontally or vertically with vertical joints over studs nailed 6″ on center with 1 3/4″ by No. 11 gauge by 7/16″ head galvanized nails. Inner layer of wallboard placed horizontally or vertically and nailed 8″ on center with 6d cooler[12] or wallboard[12] nails. Outer layer of wallboard placed horizontally or vertically and nailed 8″ on center with 8d cooler[12] or wallboard[12] nails. All joints staggered with vertical joints over studs. Outer layer joints taped and finished with compound. Nailheads covered with joint compound. No. 20 gauge corrugated galvanized steel wall ties 3/4″ by 6 5/8″ attached to each stud with two 8d cooler[12] or wallboard[12] nails every sixth course of bricks.			10	

Figure 1.14 Fire-resistive wall assemblies (continued).

Figure 1.13 illustrates what will be required for the various design criteria. The shaded areas illustrated in Figures 1.10, 1.11, l.12, and 1.13 are applicable to a proposed two-story office building.

Code Influence on Building Design

An example of code-related design requirements is provided by the site plan for the proposed two-story office building. The architect desires that all four sides of the building have windows. To satisfy this design factor, the minimum building setback from the property line will be ten feet, as indicated in Figure 1.10, under openings in exterior walls. Figure 1.15 depicts the proposed site plan for the two-story office building, showing property line setbacks satisfying one design requirement.

As the design program is developed, it is helpful to provide code-required assemblies in graphic form as a visual means for reviewing what is required for the various elements of the office building. An example of such a graphic aid is illustrated in Figure 1.16. As previously illustrated, Figures 1.12 and 1.11 determine the fire-resistive requirements for the various elements of the building, and Figure 1.14 is a partial example of some of the many acceptable construction assemblies that may be selected for the use of wall assemblies that are found in building codes.

Exit Requirements. Another very important part of a building code is the chapter dealing with egress requirements. This chapter sets forth the number of required exits for a specific occupancy use, based on an occupant load factor. The occupant load will depend on the use of the building. In the case of a two-story building that is designed for office use, the occupant load factor, as illustrated in Figure 1.17, will be 100 square feet. To determine the number of exits required, the 100 square-foot occupant load factor is divided into the office floor area of 10,000 square feet. The resultant occupant factor of 100 exceeds the factor of 30, therefore requiring a minimum of two exits.

The next step in the design program is to plan the location of the required exits, required stairs, and an acceptable egress travel. Egress travel is the path to a required exit. The codes will regulate the maximum distance between required exits, the minimum width of exit corridors, and the entire design of required exit stairways. Figure 1.18 depicts the second level floor plan of the proposed office building, illustrating an acceptable method for the planning of required exits and stair loca-

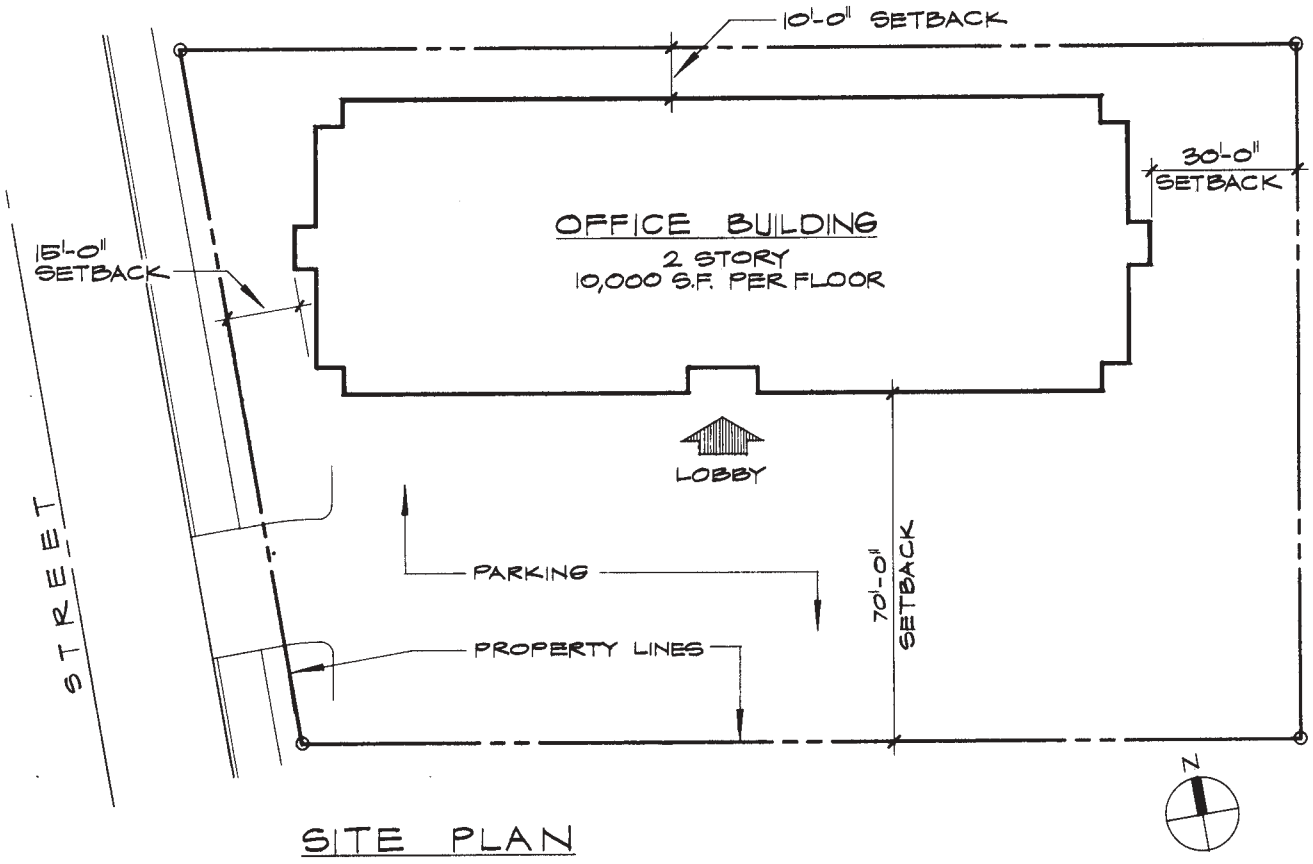


Figure 1.15 Site plan.

tions. An acceptable egress travel will terminate at the first-floor level, exiting outside the structure to a public right-of-way. A public right-of-way may be a sidewalk, street, alley, or other passage. On the first level floor plan, illustrated in Figure 1.19, the egress travel path terminates outside the building through an exit corridor at the east and west walls of the building.

This particular chapter in the *Uniform Building Code*, entitled "Exits," provides a great amount of information

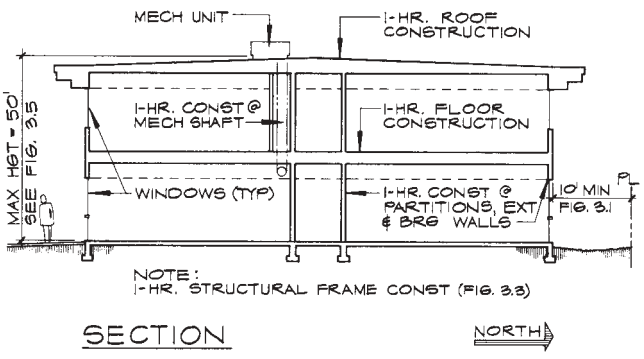


Figure 1.16 Graphic building section.

to which the architect or designer will continually refer in order to satisfy the many code regulations that will influence the planning and detailing of his or her specific building.

Code Nailing Schedule. In most cases, building code regulations determine minimum standards for the many considerations associated with the construction of a building in order to safeguard public health and welfare. However, this does not mean that the architect or the various engineers cannot increase the quality of these standards to satisfy their design solutions and opinions. An example of a minimum nailing schedule for Type V (wood) construction is illustrated in Figure 1.20. For structures subjected to wind or seismic forces, the engineered design may require more nails and a larger size of nails in order to satisfy the engineered design criteria.

Standards for Wood. The use of wood is prominent in the construction of many types of buildings currently being designed. The building codes have an extensively developed chapter for the various standards required for wood design. This chapter provides an array of tables

TABLE NO. 33-A—MINIMUM EGRESS REQUIREMENTS[1]

USE[2]	MINIMUM OF TWO EXITS OTHER THAN ELEVATORS ARE REQUIRED WHERE NUMBER OF OCCUPANTS IS AT LEAST	OCCUPANT LOAD FACTOR[3] (SQ. FT.)
1. Aircraft hangars (no repair)	10	500
2. Auction rooms	30	7
3. Assembly areas, concentrated use (without fixed seats) Auditoriums Churches and chapels Dance floors Lobby accessory to assembly occupancy Lodge rooms Reviewing stands Stadiums Waiting Area	50 50	7 3
4. Assembly areas, less-concentrated use Conference rooms Dining rooms Drinking establishments Exhibit rooms Gymnasiums Lounges Stages	50	15
5. Bowling alley (assume no occupant load for bowling lanes)	50	[4]
6. Children's homes and homes for the aged	6	80
7. Classrooms	50	20
8. Congregate residences (accommodating 10 or less persons and having an area of 3,000 square feet or less) Congregate residences (accommodating more than 10 persons or having an area of more than 3,000 square feet)	10 10	300 200
9. Courtrooms	50	40
10. Dormitories	10	50
11. Dwellings	10	300
12. Exercising rooms	50	50
13. Garage, parking	30	200
14. Hospitals and sanitariums— Nursing homes Sleeping rooms Treatment rooms Health-care center	 6 10 10	 80 80 80
15. Hotels and apartments	10	200
16. Kitchen—commercial	30	200
17. Library reading room	50	50
18. Locker rooms	30	50
19. Malls (see Chapter 56)	—	—
20. Manufacturing areas	30	200
21. Mechanical equipment room	30	300
22. Nurseries for children (day care)	7	35
23. Offices	30	100
24. School shops and vocational rooms	50	50
25. Skating rinks	50	50 on the skating area; 15 on the deck
26. Storage and stock rooms	30	300
27. Stores—retail sales rooms	50	30
28. Swimming pools	50	50 for the pool area; 15 on the deck
29. Warehouses	30	500
30. All others	50	100

[1]Access to, and egress from, buildings for persons with disabilities shall be provided as specified in Chapter 31.
[2]For additional provisions on number of exits from Groups H and I Occupancies and from rooms containing fuel-fired equipment or cellulose nitrate, see Sections 3319, 3320 and 3321, respectively.
[3]This table shall not be used to determine working space requirements per person.
[4]Occupant load based on five persons for each alley, including 15 feet of runway.

Figure 1.17 Egress requirements.

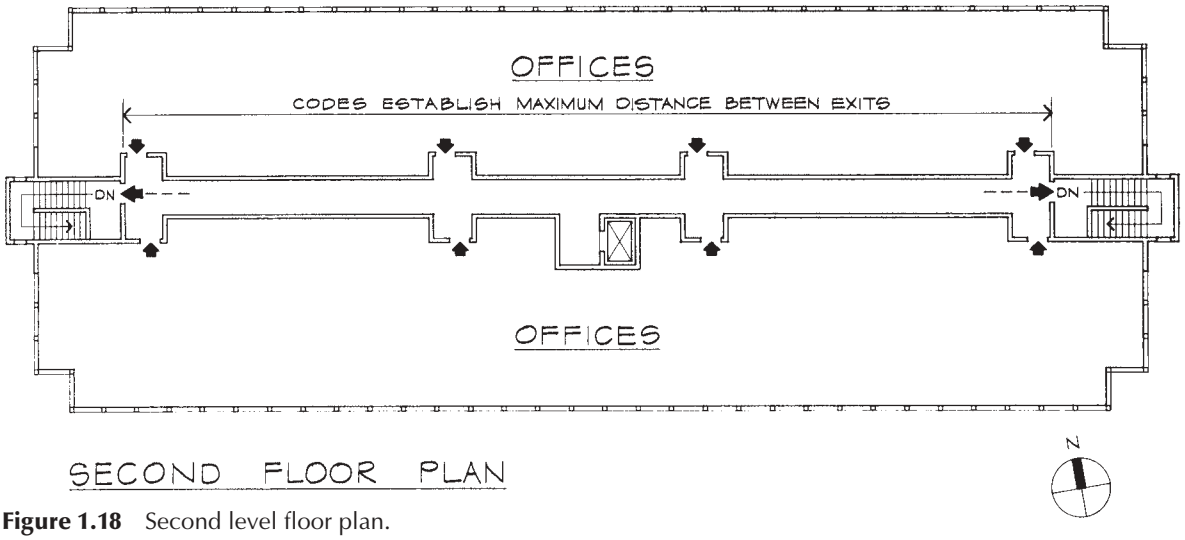


Figure 1.18 Second level floor plan.

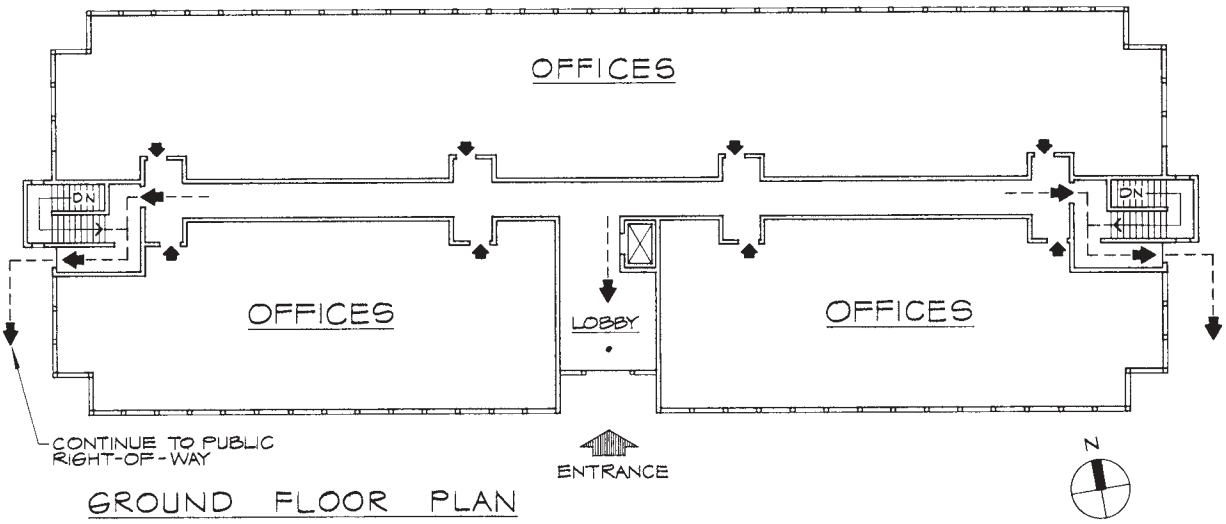


Figure 1.19 First level floor plan.

dealing with examples, such as allowable unit stresses for various types of wood species and their grades, the structural capabilities of plywood relative to its thickness and properties, the numerous species combinations for glued-laminate timber design and allowable spans for roof rafters, ceiling joists, and floor joists. An example of one of the many tables to be found in the chapter on wood is given in Figure 1.21. This table includes the allowable spans for various sizes and spacing of floor joists, based on a specific weight per square foot and on deflection design criteria.

Bolts in Concrete. For the structural design engineer or architect the building codes offer a vast number of working values for wood, concrete, masonry, and structural steel. These values provide a basis for the selection of the various components that are part of many constructions assemblies found in a specific structure. Figure 1.22 illustrates a value table for various sized anchor bolts embedded in concrete. These design loads would be the maximum allowable pounds per bolt, with a minimum embedded factor.

Minimum Foundation Requirements

As previously mentioned, many code requirements stipulate minimum standards for a specific phase of the construction process. An example is the minimum standards for foundations for wood stud-bearing walls. Figure 1.23 illustrates a table for foundations where there are no

TABLE NO. 25-O—NAILING SCHEDULE

CONNECTION	NAILING[1]
1. Joist to sill or girder, toenail	3-8d
2. Bridging to joist, toenail each end	2-8d
3. 1″ × 6″ subfloor or less to each joist, face nail	2-8d
4. Wider than 1″ × 6″ subfloor to each joist, face nail	3-8d
5. 2″ subfloor to joist or girder, blind and face nail	2-16d
6. Sole plate to joist or blocking, face nail	16d at 16″ o.c.
7. Top plate to stud, end nail	2-16d
8. Stud to sole plate	4-8d, toenail or 2-16d, end nail
9. Double studs, face nail	16d at 24″ o.c.
10. Doubled top plates, face nail	16d at 16″ o.c.
11. Top plates, laps and intersections, face nail	2-16d
12. Continuous header, two pieces	16d at 16″ o.c. along each edge
13. Ceiling joists to plate, toenail	3-8d
14. Continuous header to stud, toenail	4-8d
15. Ceiling joists, laps over partitions, face nail	3-16d
16. Ceiling joists to parallel rafters, face nail	3-16d
17. Rafter to plate, toenail	3-8d
18. 1″ brace to each stud and plate, face nail	2-8d
19. 1″ × 8″ sheathing or less to each bearing, face nail	2-8d
20. Wider than 1″ × 8″ sheathing to each bearing, face nail	3-8d
21. Built-up corner studs	16d at 24″ o.c.
22. Built-up girder and beams	20d at 32″ o.c. at top and bottom and staggered 2-20d at ends and at each splice

Figure 1.20 Nailing schedule.

frost conditions or unfavorable soils and geology reports and no excessive weights acting on the roof and floor systems.

The student or technician should constantly review the many aspects of the governing building code as it relates to the specific region and building techniques.

ENERGY CODES

The Council of American Building Officials has published a model energy code that is used by the various building code enforcement agencies throughout the country. The purpose of this code is to regulate the design of various types of new building construction, so that various methods of design can provide high efficiency in the use of energy. The basic energy design criteria for new construction deals with the building envelope, which is defined as all the elements of a building encompassing spaces that are conditioned by various sources of energy. These sources of energy are those that are required to heat, cool, and provide illumination.

Design Methods

The energy code provides methods and techniques and encourages innovative design systems to achieve an effective use of energy. There are three methods of design that are accepted as a means of compliance with the intent of the code:

I. A systems approach for the entire building and its energy-using subsystems that may use nondepletable sources. This method establishes design criteria in terms of total energy use by a building, including all of its systems.

II. A component performance approach for the various building elements and mechanical systems and components. This method provides for buildings that are heated or mechanically cooled. These are constructed so as to provide the required thermal performance of the various components.

III. Specified acceptable practice. The requirements for this method are applicable only to buildings of less than 5000 square feet in gross floor area and three stories or less in height. This method is also limited to residential buildings that are heated or mechanically cooled and to other buildings that are heated only.

Design Influences

If your project falls into the category of Method III, you will be faced with many design decisions as to the construction of the various assemblies within the building envelope, as well as in the selection of mechanical and electrical equipment. Examples of building assemblies include the design and detailing of elements such as the roof, floors, and walls. For these detailed assemblies, it will be necessary to provide the required amount of insulation and to use the method that satisfies the design and energy code criteria.

For the energy design program, it is recommended that the architect or designer develop a typical building section in order to visualize the various building elements that will be affected by the energy design requirements. Figure 1.24 illustrates a building section showing elements of the building envelope that will have to be insulated. In some cases the size of some of the members of the envelope may need to be increased to accommodate the required depth of insulation, such as the depth of wood studs and roof joist. Items such as windows and skylights (in Figure 1.24) will be of major concern in the