CHAPTER 1

An Overview of the Building Delivery Process (How Buildings Come into Being)

CHAPTER OUTLINE

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Building construction is a complex, significant, and rewarding process. It begins with an idea and culminates in a structure that may serve its occupants for several decades, even centuries. Like the manufacturing of products, building construction requires an ordered and planned assembly of materials. It is, however, far more complicated than product manufacturing. Buildings are assembled outdoors by a large number of diverse constructors and artisans on all types of sites and are subject to all kinds of weather conditions.

Additionally, even a modest-sized building must satisfy many performance criteria and legal constraints, requires an immense variety of materials, and involves a large network of design and production firms. Building construction is further complicated by the fact that no two buildings are identical; each one must be custom built to serve a unique function and respond to its specific context and the preferences of its owner, user, and occupant.

Because of a building's uniqueness, we invoke first principles in each building project. Although it may seem that we are "reinventing the wheel", we are in fact refining and improving the building delivery process. In so doing, we bring to the task the collective wisdom of the architects, engineers, and contractors who have done so before us. Although there are movements that promote the development of standardized, mass-produced buildings, these seldom meet the distinct needs of each user.

Regardless of the uniqueness of each building project, the flow of activities, events, and processes necessary for a project's realization is virtually the same in all buildings. This chapter presents an overview of the activities, events, and processes that bring about a building—from the inception of an idea or a concept in the owner's mind to the completed design by the architects and engineers and, finally, to the actual construction of the building by the contractor.

Design and construction are two independent but related and generally sequential functions in the realization of a building. The former function deals with the creation of the documents, and the latter function involves interpreting and transforming these documents into reality—a building or a complex of buildings.

The chapter begins with a discussion of various stakeholders (personnel involved in the design and construction of the project) and the relational framework among them. Subsequently, a description of the two major elements of design documentation—construction drawings and specifications—is provided. Finally, the chapter examines some of the methods used for bringing a building into being, referred to as the *project delivery methods*. From the owner's perspective, these methods are called *project acquisition methods*.

The purpose of this chapter, as its title suggests, is to provide an overall, yet distilled, view of the construction process and its relationship with design. Although several contractual and legal issues are discussed, they should be treated as introductory. A reader requiring additional information on these topics should refer to texts specially devoted to them.

1.1 PROJECT DELIVERY PHASES

The process by which a building project is delivered to its owner may be divided into the following five phases, referred to as the *project delivery phases*. Although there is usually some overlap between adjacent phases, they generally follow this order:

- Predesign phase
- Design phase
- Preconstruction phase
- Construction phase
- Postconstruction phase

1.2 PREDESIGN PHASE

During the predesign phase (also called the *planning* or *programming phase*), the project is defined in terms of its function, purpose, scope, size, and economics. This is the most crucial of the five phases, and is almost always managed by the owner and the owner's team. The success or failure of the project may depend on how well this phase is defined, detailed, and managed. Obviously, the clearer the project's definition is, the easier it is to proceed to the subsequent phases. Some of the important predesign tasks are:

- Details of the project's program.
- Economic feasibility assessment, including the project's overall budget and financing.
- Site assessment and selection, including the verification of the site's appropriateness, and determining its designated land use (see Chapter 2).
- Governmental constraints assessment, for example, building code and zoning constraints (see Chapter 2) and other legal aspects of the project.
- Sustainability rating—whether the owner would like the project to achieve sustainability rating, such as the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) certification at some level (see Chapter 10).
- Design team selection.

Building (Project) Program

This includes defining the activities, functions, and spaces required in the building, along with their approximate sizes and their relationships with each other. For a house or another small project, the program is usually simple and can be developed by the owner without external assistance. For a large project, however, where the owner may be an institution (such as a corporation, school board, hospital, religious organization, or governmental entity), developing the program may be a complex exercise. This may be due to the size and complexity of the project or the need to involve several individuals—a corporation's board of directors, for example—in decision making. These constituencies may have different views of the project, making it difficult to create a consensus.

Program development may also be complicated by situations in which the owner has a fuzzy idea of the project and is unable to define it clearly. By contrast, experienced owners tend to have a clear understanding of the project and generally provide a detailed, unambiguous program to the architect.

Although the owner must provide the program details to the architect, it is not unusual for the owner to involve the architect in preparing the program for some architecturally complex projects. In this instance, the architect may be hired early during the predesign phase. Note that the architect's role in the preparation of the building program is not considered a part of the architect's "basic" services, but as an "additional" service, compensated separately [Ref. 1.1].

Whatever the situation, preparing the program is the first step in the project delivery process. It should be spelled out in writing and in sufficient detail to guide the design, reduce the liability risk for the architect, and avoid its misinterpretation. If a revision is made during the progress of the project, the owner's written approval is necessary.

NOTE

Building (Project) Program

The American Institute of Architects (AIA) Document B141-1997, *Standard Form of Agreement Between Owner and Architect*, defines the building program: "A program is a written statement setting forth design objectives, constraints, and criteria for a project . . . . A program includes space requirements and relationships, flexibility and expandability, special equipment and systems, and site requirements. If a comprehensive program is not available at the outset of the project, the owner may obtain the architect's assistance in developing one as an expansion of services".

1.3 DESIGN PHASE

The design phase begins after the selection of the architect. Because the architect (usually a firm) may have limited capabilities for handling the broad range of building-design activities, several different, more specialized consultants are usually required, depending on the size and scope of the project.

In most projects, the design team consists of the architect, landscape architect, civil and structural consultants, and mechanical, electrical, and plumbing (MEP) consultants. In complex projects, the design team may also include an acoustical consultant, roofing and waterproofing consultant, cost consultant, building code consultant, signage consultant, interior designer, and so on.

Some design firms have an entire design team (architects and specialized consultants) on staff, in which case, the owner will contract with a single firm. Generally, however, the design team comprises several different design firms. In such cases, the owner typically contracts the architect, who in turn contracts the remaining design team members, Figure 1.1.

Thus, the architect functions as the prime design professional and, to a limited degree, as the owner's representative. The architect is liable to the owner for his or her own work and that of the consultants. For that reason, most architects ensure that their consultants carry adequate liability insurance.

ARCHITECT'S LIABILITY FOR WORK DONE BY OWNER-CONTRACTED CONSULTANT

In some projects, the owner may contract some consultants directly, particularly a civil consultant (for a survey of the site, site grading, slope stabilization, and the design of site drainage system), a geotechnical consultant (for investigation of the soil properties), and a landscape architect (for landscape and site design), Figure 1.2. These consultants may be engaged before or at the same time as the architect.

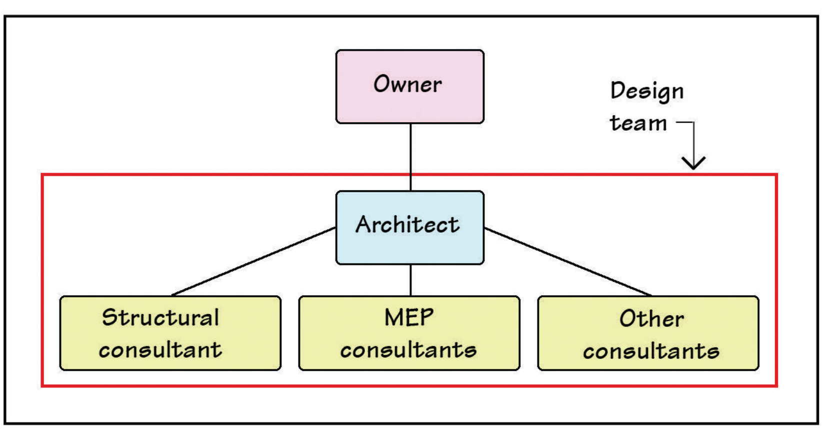


FIGURE 1.1 Members of a typical design team, and their interrelationships with each other and the owner in a traditional contractual set-up. A line in this illustration indicates a contractual relationship between parties. ("MEP consultants" is an acronym for mechanical, electrical, and plumbing consultants.)

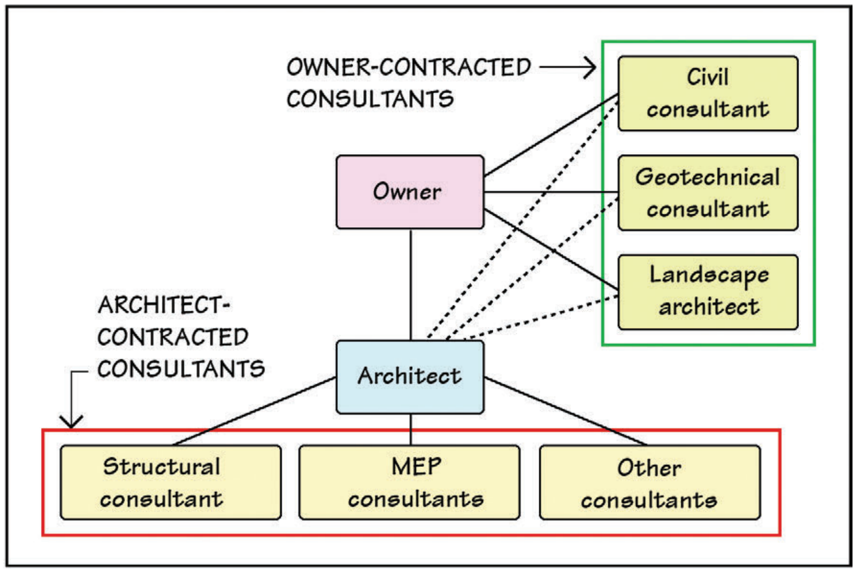


FIGURE 1.2 Members of a typical design team, and their interrelationships with each other and the owner in a project where some consultants are contracted directly by the owner. A solid line in this illustration indicates a contractual relationship between parties. A dashed line indicates a communication link, not a contract.

Even when a consultant is contracted directly by the owner, the architect retains some liability for the consultant's work. This liability occurs because the architect, being the prime design professional, coordinates the entire design effort, and the consultants' work is influenced a great deal by the architectural decisions. Therefore, the working relationship between the architect and an owner-contracted consultant remains essentially the same as if the consultant were chosen by the architect.

Engineer as Prime Design Professional

In some cases, an engineer or another professional may coordinate the design process. This generally occurs where architectural design is a minor component of a large-scale project. For example, in a highly technical project such as a power plant, an electrical engineer may be the prime design professional.

1.4 THREE SEQUENTIAL STAGES IN DESIGN PHASE

In most building projects, the design phase consists of three stages, which occur in the following sequence:

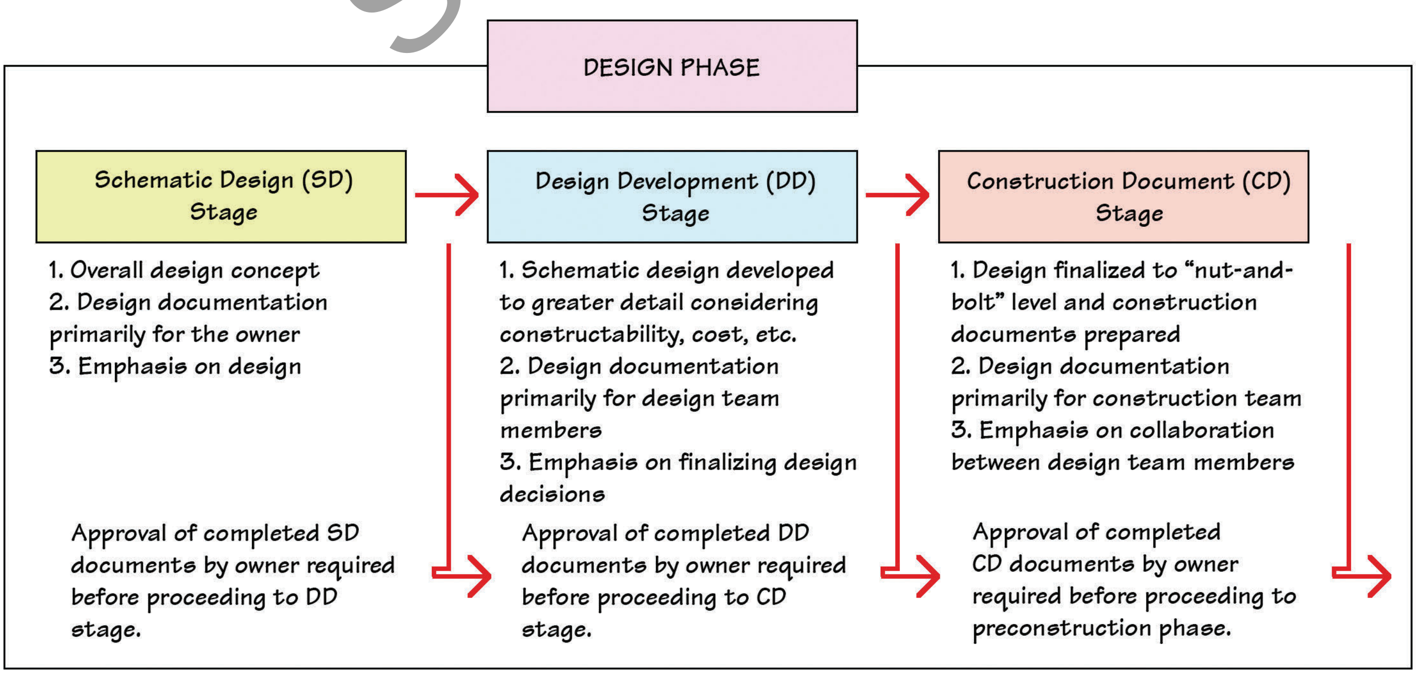


FIGURE 1.3 Three sequential stages (steps) of the design phase and the important tasks accomplished in each stage.

- Schematic design (SD) stage
- Design development (DD) stage
- Construction document (CD) stage

Figure 1.3 illustrates the sequence and the important tasks accomplished in each stage. Note that at the end of each stage, a written approval from the owner is required before proceeding to the next stage, or from the design phase to the preconstruction phase.

Schematic Design Stage—Emphasis on Design

The schematic design gives graphic shape to the project program. It is an overall concept that illustrates key ideas of the design solution. The major player in this stage is the architect, who develops the design scheme (or several design options), generally with limited help from the consultants. Because most projects have strict budgetary limitations, a rough estimate of the project's probable cost is generally produced at this stage.

The schematic design usually goes through several revisions, because the first design scheme prepared by the architect will rarely be approved by the owner. The architect communicates the design proposal(s) to the owner through various types of drawings—plans, elevations, sections, freehand sketches, and three-dimensional graphics (isometrics, axonometrics, and perspectives). For some projects, a three-dimensional scale model of the entire building or the complex of buildings, showing the context (neighboring buildings) within which the project is sited, may be needed.

With significant developments in electronic media technology, especially building information modeling (BIM), computer-generated imagery has become common in architecture and related engineering disciplines. Computer-generated walk-through and flyover simulations are becoming increasingly popular for communicating the architect's design intent to the owner at the SD stage.

It is important to note that the schematic design drawings, images, models, and simulations, regardless of how well they are produced, are not adequate to construct the building. Their objective is merely to communicate the design scheme to the owner (and to consultants, who may or may not be on board at this stage), not to the contractor.

Design Development Stage—Emphasis on Decision Making

Once the schematic design is approved by the owner, the process of designing the building in greater detail begins. During this stage, the schematic design is developed further—hence the term *design development* (DD) stage.

While the emphasis in the SD stage is on the creative, conceptual, and innovative aspects of design, the DD stage focuses on developing practical, pragmatic, and constructible solutions for the exterior envelope, structure, fenestration, interior systems, MEP systems, and so forth. This development involves strategic consultations with all members of the design team.

Therefore, the most critical feature of the DD stage is decision making, which ranges from broad design aspects to finer details. At this stage, the vast majority of decisions about products, materials, and equipment are made. Efficient execution of the construction documents depends directly on how well the DD is managed. A more detailed version of the specifications and probable cost of the project is also prepared at this stage.

Construction Documents Stage—Emphasis on Documentation

The purpose of the *construction documents* (CD) stage is to prepare all documents required by the contractor to construct the building. During this stage, the consultants and architect collaborate intensively to work out the "nuts and bolts" of the building and develop the required documentation, referred to as *construction documents*. All of the consultants advise the architect, but they also collaborate with each other (generally through the architect) so that the work of one consultant agrees with that of the others.

The construction documents consist of the following items:

- Construction drawings
- Specifications

Construction Drawings

During the CD stage, the architect and consultants prepare their own sets of drawings, referred to as *construction drawings*. Thus, a project has architectural construction drawings, civil and structural construction drawings, MEP construction drawings, landscape construction drawings, and so on.

NOTE

Working Drawings and Construction Drawings

The term working drawings was used until the end of the twentieth century for what are now commonly referred to as *construction drawings*.

Construction drawings are dimensioned drawings (usually computer generated) that fully delineate the building. They consist of floor plans, elevations, sections, schedules, and various large-scale details. The details depict a small portion of the building that cannot be adequately described on smaller-scale plans, elevations, or sections.

Construction drawings are the drawings that the construction team uses to build the building. Therefore, they must indicate the geometry, layout, dimensions, types of materials, details of assembling the components, colors and textures, and so on. Construction drawings are generally two-dimensional drawings, but three-dimensional isometrics are sometimes used for complex details. Construction drawings are also used by the contractor to prepare a detailed cost estimate of the project at the time of bidding.

Construction drawings are not a sequence of assembly instructions, such as for a bicycle. Instead, they indicate what every component is and where it will be located when the building is completed. In other words, the design team decides the “what” and “where” of the building. The “how” and “when” (means, methods, and sequencing) of construction are entirely in the contractor’s domain.

Specifications

Buildings cannot be constructed from drawings alone, because there is a great deal of information that cannot be included in the drawings. For instance, the drawings will give the locations of columns, their dimensions, and the material used (such as reinforced concrete), but the quality of materials, their properties (the strength of concrete, for example), and the test methods required to confirm compliance cannot be furnished on the drawings. This information is included in the document called *specifications*.

Specifications are written technical descriptions of the design intent, whereas the drawings provide the graphic description. The two components of the construction documents—the specifications and the construction drawings—complement each other and generally deal with different aspects of the project. Because they are complementary, they are supposed to be used in conjunction with each other. There is no order of precedence between the construction drawings and the specifications. Thus, if an item is described in only one place—either the specification or the drawings—it is part of the project, as if described in the other.

For instance, if the construction drawings do not show the door hardware (hinges, locks, handles, and other components) but the hardware is described in the specifications, the owner will get the doors with the stated hardware. If the drawings had precedence over the specifications, the owner would receive doors without hinges and handles.

Generally, there is little overlap between the drawings and the specifications. More importantly, there should be no conflict between them. If a conflict between the two documents is identified, the contractor must bring it to the attention of the architect promptly. In fact, construction contracts generally require that before starting any portion of the project, the contractor must carefully study and compare the drawings and the specifications and report inconsistencies to the architect.

If the conflict between the specifications and the construction drawings goes unnoticed initially but later results in a dispute, the courts have in most cases resolved it in favor of the specifications—implying that the specifications, not the drawings, govern the project. However, if the owner or the design team wishes to reverse the order, it can be so stated in the owner-contractor agreement.

EXPAND YOUR KNOWLEDGE

Relationship Between Construction Drawings and Specifications

Construction Drawings	Specifications
Design intent represented graphically	Design intent represented with words
Product/material may be shown many times	Product/material described only once
Product/material shown generically	Product/material identified specifically, sometimes proprietary to a manufacturer
Quantity indicated	Quality indicated
Location of elements established	Installation requirements of elements established
Size, shape, and relationship of building elements provided	Description, properties, characteristics, and finishes of building elements provided

The Construction Document Set

Just as the construction drawings are prepared separately by the architect and each consultant for their respective portions of the work, so are the specifications. The specifications from various design team members are assembled by the architect in a single document. Because the specifications are in text format (not as drawings), they are bound in book format. A few other items are also included in this document at a later stage, and the entire bound document is called the *project manual*, described in Section 1.7. The construction drawings plus the specifications constitute the construction document set, Figure 1.4 (see also Figure 1.11). Although hardcopy drawings and specification are common, their digital versions are being increasingly used.

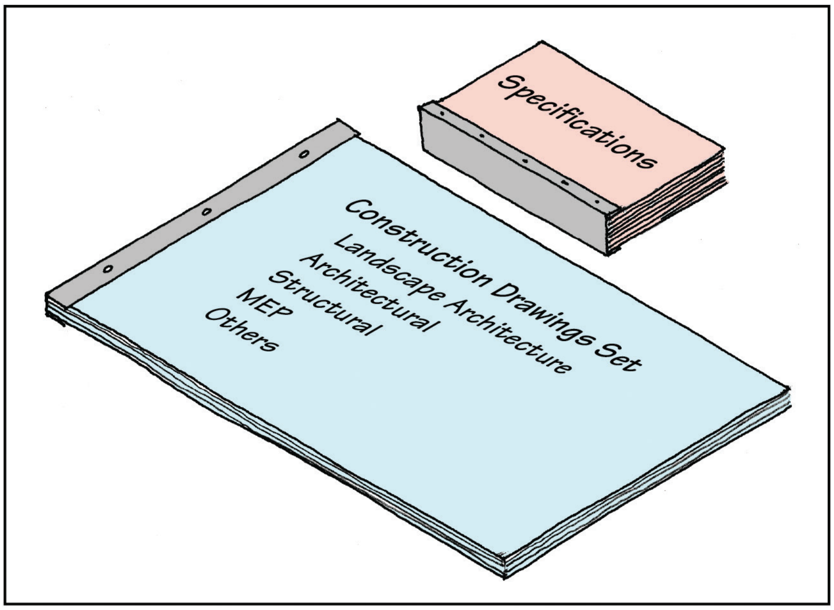


FIGURE 1.4 A construction document set consists of a set of architectural and consultants' construction drawings plus the specifications prepared by the architect and the consultants. The specifications are bound in book format along with other items.

Owner's Role During Design Phase

The owner's role in the design phase of the project may not appear as active as in the predesign phase, but it is important all the same. In fact, a conscientious owner will be fully involved throughout the entire project delivery process—from the predesign phase through the project closeout phase.

PRACTICE QUIZ

Each question has only one correct answer. Select the choice that best answers the question.

1. The delivery of a typical building project, as described in this text, may be divided into
   - **a.** two phases.
   - **b.** three phases.
   - **c.** four phases.
   - **d.** five phases.
   - **e.** six phases.

2. Establishing the project's economic feasibility and its overall budget is part of the design phase of the project.
   - **a.** True
   - **b.** False

3. The term MEP is an acronym for
   - **a.** municipal emergency plan.
   - **b.** mechanical, electrical, and plumbing.
   - **c.** mechanical, electrical, and piping.
   - **d.** mechanical and electrical plans.
   - **e.** mechanical and electrical plant.

4. The program for a building project is prepared by the
   - **a.** owner.
   - **b.** general contractor.
   - **c.** building official of the city.
   - **d.** architect.
   - **e.** all of the above collectively.

5. In a typical building project, the coordination of the building's design is done by the
   - **a.** owner.
   - **b.** general contractor.
   - **c.** building official of the city.
   - **d.** architect.
   - **e.** any one of the above, depending on the type of building.

6. The construction drawings of a building project are prepared during the
   - **a.** SD stage of the project.
   - **b.** DD stage of the project.
   - **c.** CD stage of the project.
   - **d.** preconstruction phase of the project.
   - **e.** construction phase of the project.

7. The construction drawings of a building project are drawings that the architect uses to explain the design to the owner.
   - **a.** True
   - **b.** False

8. The construction drawings of a building project are generally in the form of
   - **a.** freehand sketches.
   - **b.** two-dimensional plans, elevations, sections, and details.
   - **c.** three-dimensional drawings.
   - **d.** photographs of three-dimensional scale model(s).
   - **e.** all of the above.

9. The construction drawings for a building project generally consist of
   - **a.** architectural drawings and structural drawings.
   - **b.** architectural drawings, structural drawings, and MEP drawings.
   - **c.** architectural drawings, structural drawings, MEP, and QSA drawings.
   - **d.** architectural drawings, structural drawings, and QSA drawings.
   - **e.** none of the above.

10. The construction document set consists of
    - **a.** construction drawings.
    - **b.** construction drawings and construction schedule.
    - **c.** construction drawings, construction schedule, and owner-contractor agreement.
    - **d.** construction drawings, construction schedule, and specifications.
    - **e.** construction drawings and specifications.

11. The specifications of a typical building project are prepared by the
    - **a.** architect.
    - **b.** architect in collaboration with the GC.
    - **c.** architect in collaboration with the GC and the architect's consultants.
    - **d.** architect and the architect's consultants.
    - **e.** none of the above.

1.5 CSI MASTERFORMAT AND SPECIFICATIONS

The specification document for even a modest-sized project can run into hundreds of pages. It is used not only by the contractor and the subcontractors, but also by the owner, the material suppliers, and in fact, the entire construction team. With so many different people using it, it is necessary that the specifications be organized in a standard format so that each user can go to the section of particular interest without having to wade through the entire document.

The standard organizational format for specifications, referred to as *MasterFormat*, has been developed by the Construction Specifications Institute (CSI) and is the format most commonly used in the United States and Canada. MasterFormat is divided into two groups—(i) *Procurement and Contracting Requirements* group and (ii) *Specifications* group, Figure 1.5. The Specifications group is further divided into five subgroups, and each subgroup consists of divisions. The subgroup *General Requirements* comprises one division; *Facilities Construction* subgroup has 18 divisions; and the following three subgroups have 10 divisions each.

The total number of divisions in MasterFormat is 50, which are identified using six-digit numbers. The first two digits of the numbering system (referred to as *Level 1* digits) identify the division number. The 50 division numbers are 00, 01, 02, 03, . . . , 48, and 49. A division identifies the broadest collection of related products and assemblies, such as Division 03—Concrete.

The next two digits of the numbering system (*Level 2* digits) refer to various sections within the division, and the last two digits (*Level 3* digits) refer to the subsections within a section. In other words, Level 2 and Level 3 digits classify products and assemblies into progressively closer affiliations. Thus, Level 1 digits in MasterFormat may be compared to chapter numbers in a book, Level 2 digits to section numbers of a chapter, and Level 3 digits to subsection numbers of a section.

A complete list of MasterFormat titles is voluminous. Figure 1.6 provides a bird's-eye view of MasterFormat, showing groups, subgroups, and divisions in each subgroup. It also provides additional details of one of the divisions, Division 04—Masonry—as brief illustration of the numbering system. Note that the *Procurement and Contracting Requirements* group is Division 00 and the *Specifications* group consists of Divisions 01 to 49.

Also note that MasterFormat deals with all types of construction (new buildings, renovations, and maintenance). Construction work and products, not directly related with buildings (services, urban infrastructural construction, equipment, etc.) are also included—in Divisions 30 to 49.

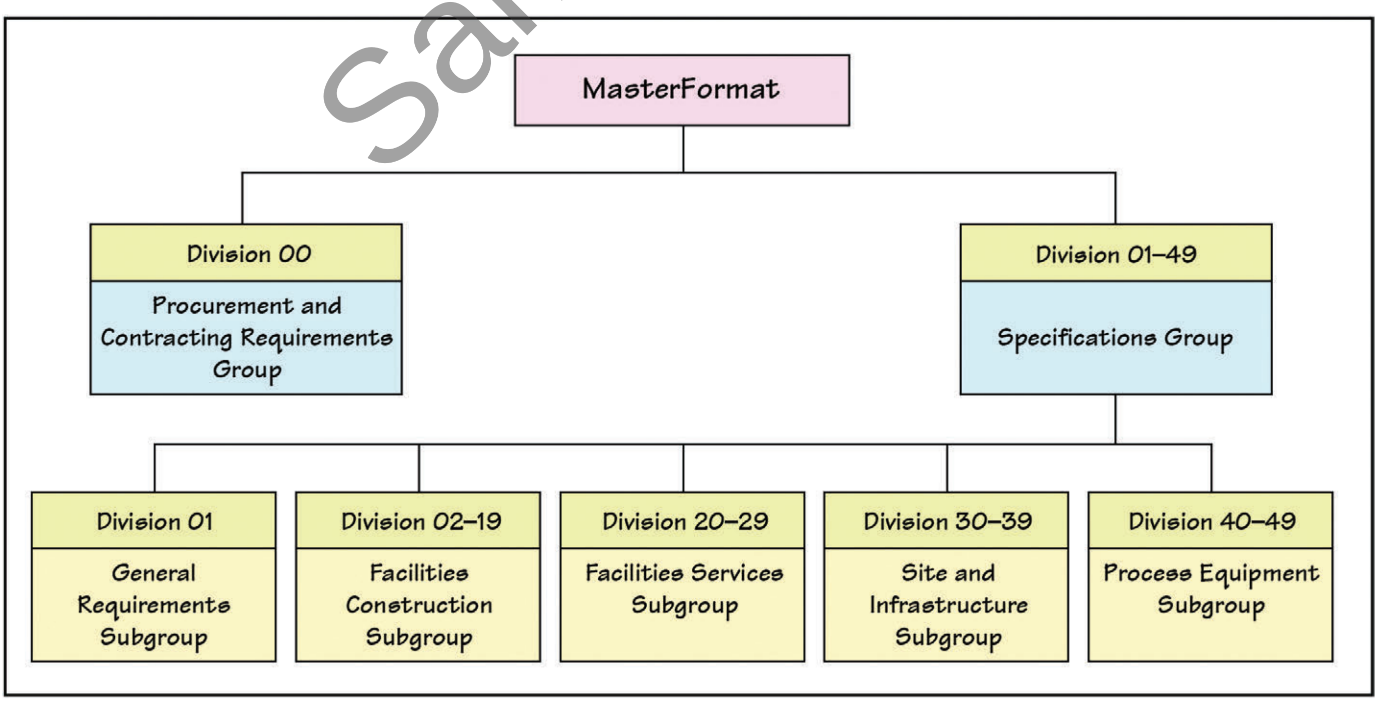


FIGURE 1.5 Structure of the MasterFormat, showing its separation into two groups—(i) Procurement and Contracting Requirements group and (ii) Specifications group. The Specifications group is further divided into five subgroups. Each subgroup is divided into a number of divisions.

50 Divisions of the MasterFormat

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

Division 00 Procurement and Contracting Requirements

SPECIFICATIONS GROUP

Div. 01 General Requirements

FACILITIES CONSTRUCTION SUBGROUP

Div. 02 Existing Conditions
Div. 03 Concrete
Div. 04 Masonry
Div. 05 Metals
Div. 06 Wood, Plastics, and Composites
Div. 07 Thermal and Moisture Protection
Div. 08 Openings
Div. 09 Finishes
Div. 10 Specialities
Div. 11 Equipment
Div. 12 Furnishings
Div. 13 Special Construction
Div. 14 Conveying Equipment
Div. 15 Reserved for Future Expansion
Div. 16 Reserved for Future Expansion
Div. 17 Reserved for Future Expansion
Div. 18 Reserved for Future Expansion
Div. 19 Reserved for Future Expansion

FACILITIES SERVICES SUBGROUP

Div. 20 Reserved for Future Expansion
Div. 21 Fire Suppression
Div. 22 Plumbing
Div. 23 Heating, Ventilating, and Air Conditioning
Div. 24 Reserved for Future Expansion
Div. 25 Integrated Automation
Div. 26 Electrical
Div. 27 Communications
Div. 28 Electronic Safety and Security
Div. 29 Reserved for Future Expansion

SITE AND INFRASTRUCTURE SUBGROUP

Div. 30 Reserved for Future Expansion
Div. 31 Earthwork
Div. 32 Exterior Improvements
Div. 33 Utilities
Div. 34 Transportation
Div. 35 Waterway and Marine Construction
Div. 36 Reserved for Future Expansion

Level 1 digits
Level 2 digits
Level 3 digits

04 00 00	MASONRY
04 01 00	Maintenance of Masonry
04 03 00	Conservation Treatment for Period Masonry
04 05 00	Common Work Results for Masonry
04 06 00	Schedules for Masonry
04 08 00	Commissioning of Masonry
04 20 00	Unit Masonry
04 21 00	Clay Unit Masonry
04 22 00	Concrete Unit Masonry
04 23 00	Glass Unit Masonry
04 24 00	Adobe Unit Masonry
04 25 00	Unit Masonry Panels
04 26 00	Single-Wythe Unit Masonry
04 27 00	Multiple-Wythe Unit Masonry
04 28 00	Concrete Form Masonry Units
04 29 00	Engineered Unit Masonry
04 40 00	Stone Assemblies
04 41 00	Dry-Placed Stone
04 42 00	Exterior Stone Cladding
04 43 00	Stone Masonry
04 50 00	Refractory Masonry

Div. 37 Reserved for Future Expansion
Div. 38 Reserved for Future Expansion
Div. 39 Reserved for Future Expansion

PROCESS EQUIPMENT SUBGROUP

Div. 40 Process Interconnections
Div. 41 Material Processing and Handling Equipment
Div. 42 Process Heating, Cooling, and Drying Equipment
Div. 43 Process Gas and Liquid Handling, Purification, and Storage Equipment
Div. 44 Pollution and Waste Control Equipment
Div. 45 Industry-Specific Manufacturing Equipment
Div. 46 Water and Wastewater Equipment
Div. 47 Reserved for Future Expansion
Div. 48 Electrical Power Generation
Div. 49 Reserved for Future Expansion

FIGURE 1.6 MasterFormat divisions. The first few sections (Level 2 details) of Masonry division have been highlighted in a box. Level 3 details would show further divisions of a section. For example, 04 23 13 covers the specifications of vertical glass unit masonry, 04 23 16 covers glass unit masonry floors, and 04 23 19 covers glass unit masonry skylights.

Recollecting MasterFormat Division Sequence

Architectural design typically involves Divisions 02 to 14 of the Facilities Construction subgroup. Although the basis for sequencing the Divisions in this subgroup is far more complicated, the first few divisions (that are used in virtually all buildings) may be deduced by visualizing the sequence of operations required in constructing the simple building shown in Figure 1.7. The building consists of load-bearing masonry walls, steel roof joists, and wood roof deck.

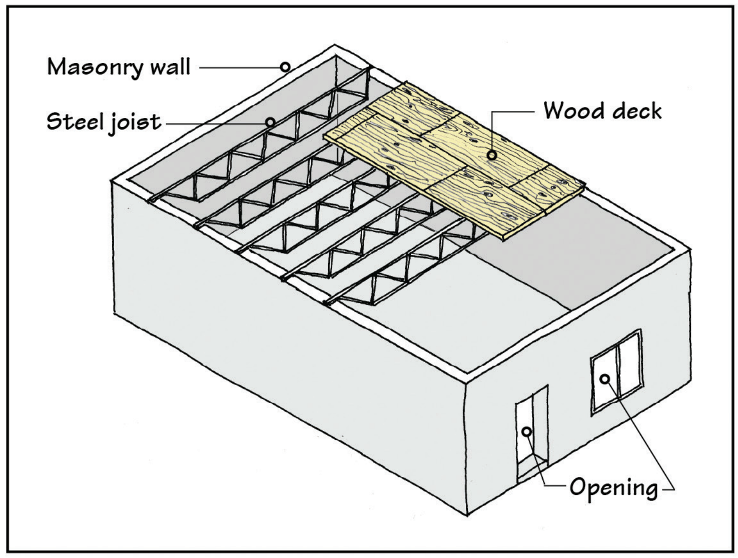


FIGURE 1.7 A simple load-bearing masonry wall building with steel roof joists and wood roof deck, used as an aid to recalling the sequence of first few divisions of the MasterFormat.

NOTE

Difference Between Specialties (Division 10) and Special Construction (Division 13)

Specialties (Division 10) includes prefabricated items such as marker boards, chalkboards, tackboards, lockers, shelves, grilles and screens, louvers and vents, flagpoles, manufactured fireplaces, and demountable partitions.

Special Construction (Division 13) includes items that are generally site fabricated but are not covered in other divisions, such as air-supported fabric structures, swimming pools, ice rinks, aquariums, planetariums, geodesic structures, and sound and vibration control.

Obviously, the first operation in constructing such a building is to excavate for foundations and lay below-ground utility lines (water supply, sewage, electrical and telecommunication lines, etc.). Because excavation deals with earthwork, MasterFormat includes it in Division 31 (Site and Infrastructure subgroup). After earthwork, the next operation is to construct foundations. Because foundations are typically made of concrete, *Concrete* is Division 03. After the foundations have been completed, masonry work for the walls can begin. Thus, *Masonry* is Division 04. After the walls are completed, steel roof joists can be placed. Thus, Division 05 is *Metals*. The installation of wood roof deck follows that of the steel joists. Hence, *Wood, Plastics, and Composites* constitute Division 06.

After the roof deck is erected, it must be insulated and protected against weather. Therefore, *Thermal and Moisture Protection* is Division 07. Roofing and waterproofing (of basements) are part of this division, as are insulating materials and joint sealants. The next step is to protect the rest of the envelope; hence, Division 08 is *Openings*. All doors and windows are part of this division, regardless of whether they are made of steel, aluminum, or wood.

With the envelope protected, finish operations, such as those involving the interior drywall, flooring, and ceiling, can begin. Thus, Division 09 is *Finishes*. Division 10 is *Specialties*, which consists of several items that cannot be included in the previous divisions, such as toilet partitions, lockers, storage shelving, and movable partitions.

Obviously, the building must now receive all the necessary office, kitchen, laboratory, or other equipment. Thus, Division 11 is *Equipment*. Division 12 is *Furnishings*, followed by *Special Construction* (Division 13) and *Conveying Equipment* (Division 14).

Division 01 and Division 02

Before beginning with the coverage of individual materials and products, the MasterFormat covers items that apply to all of them, such as price and payment procedure, product substitution procedure, and contract modification procedure. These items are included in Division 01, titled as *General Requirements*, and illustrated in Figure 1.8. This illustration also provides items covered in Division 02—*Existing Conditions*.

Division 01 comes into effect during the construction phase, but all parties involved in the project (particularly the owner and the contractor) must know of their respective roles and obligations, detailed in this division, before signing the construction contract. By contrast Division 00, discussed in Section 1.7, comes into effect when the project is ready for soliciting bids for construction, that is, during the preconstruction phase.

MasterFormat and Construction-Related Information

Familiarity with MasterFormat is required to prepare the project manual and write the specifications for the project. It is also helpful in filing and storing construction information in an office. Material manufacturers also use MasterFormat division numbers in catalogs and publications provided to design and construction professionals. MasterFormat is also helpful when seeking information about a construction material or system, as any serious student of construction (architect, engineer, or builder) must frequently do.

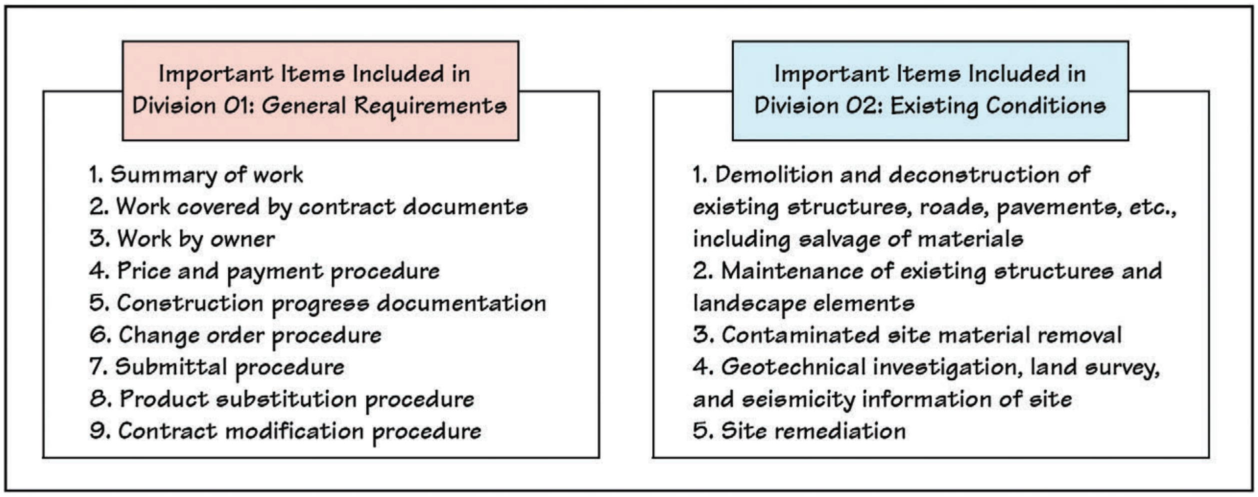


FIGURE 1.8 Important items included in MasterFormat Division 01 and Division 02.

1.6 THE CONSTRUCTION TEAM

The construction of even a small building involves so many specialized skills and trades that the work cannot normally be undertaken by a single construction firm. Instead, the work is generally done by a team consisting of the general contractor (GC) and a number of specialty subcontractors, Figure 1.9. Thus, a project may have roofing, window and curtain wall, plumbing, and heating, ventilation, and air-conditioning (HVAC) subcontractors among others, in addition to the general contractor. The general contractor's own work may be limited to certain components of the building (such as the structural components—load-bearing walls, reinforced concrete beams and columns, and roof and floor slabs), with all the remaining work subcontracted.

In contemporary projects, however, the trend is toward the general contractors not performing any actual construction work but subcontracting the work entirely to various subcontractors. Because the subcontractors are contracted by the general contractor, only the GC is responsible and liable to the owner.

In some cases, a subcontractor will, in turn, subcontract a portion of his or her work to another subcontractor, referred to as a *second-tier subcontractor*. In that case, the GC deals only with the subcontractor, not the second-tier subcontractor.

Whether the GC performs part of the construction work or subcontracts the entire work, the key function of the GC is the overall management of construction. This includes coordinating the work of all subcontractors, ensuring that the work done by them is completed in accordance with the contract documents, and ensuring the safety of all workers on the site. A GC with a good record of site safety not only demonstrates respect for the workers but also improves the profit margin by lowering the cost of construction insurance.

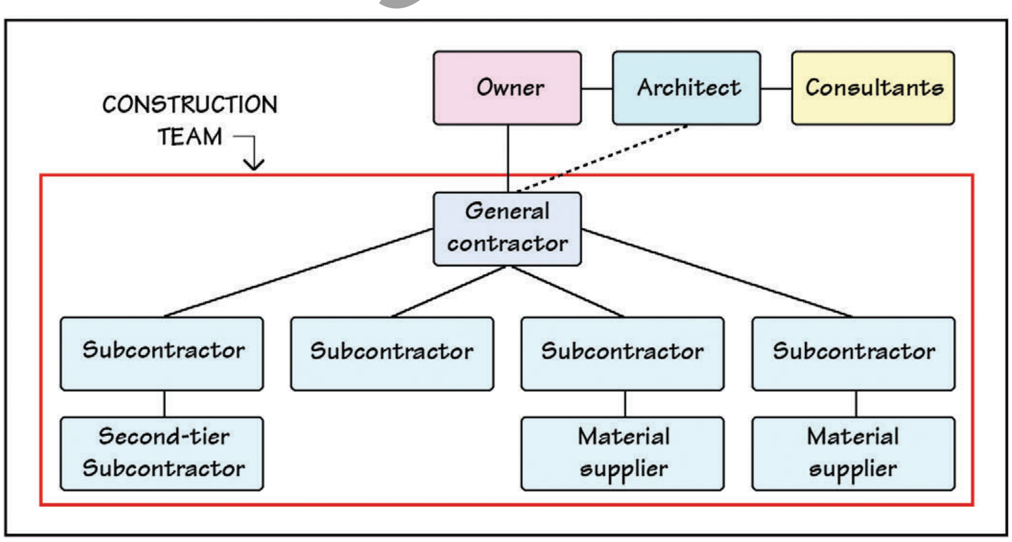


FIGURE 1.9 The construction team and their interrelationships with each other and the owner. A solid line in this illustration indicates a contractual relationship between parties. A dashed line indicates a communication link. The relationships shown here are not absolute and may change somewhat with the nature of the project.

DESIGN AND CONSTRUCTION CONTRACTS AS TWO-PARTY CONTRACTS

It is important to note at this stage that all design and construction contracts are two-party contracts, such as owner-architect contract, owner-GC contract, architect-consultant contracts, and GC-subcontractor contracts. Multiparty design or construction contracts do not exist (except in the integrated project delivery method, described in Section 1.17).

1.7 PRECONSTRUCTION PHASE: THE BIDDING DOCUMENTS

The preconstruction phase comprises two important activities: preparation of bidding documents (also called *bid package*) and the selection of the GC. The bidding documents are prepared by the architect with the help of the entire design team. They are documents that are used by the GC to bid for the construction of the project. They include (i) construction documents, which comprises construction drawings and specifications (Divisions 01 to 49) and (ii) Division 00.

Division 00, titled as *Procurement and Contracting Requirements*, contains legal and contractual information that the GC must be aware of before preparing the bids. For the ease of grasping its contents, Division 00 may be divided into four parts: (a) bid procurement requirements, (b) contract requirements, (c) contract administration, and (d) available project information, Figure 1.10.

As shown in Figure 1.10, the *bid procurement* part of Division 00 refers to items that a GC will typically not deal with after signing the contract, such as instruction to bidders, prebid meetings, and bid bond information. The *contract requirements* part contains owner-GC agreement, conditions of contract, etc. *Contract administration* includes performance and payment bond details, and requirements for certificates of substantial and final completion. *Available project information* relates to land survey, geotechnical information, geophysical information, etc. An important component of geophysical information is the degree of seismicity of the site.

The bidding documents may also contain addenda. An addendum refers to a document that is added to the original construction documents during the bidding period because of the errors or omissions observed after the bidding documents have been released to the bidders. An addendum may also become necessary in response to questions raised during a prebid meeting by the prospective bidders.

After the contract has been awarded to the successful bidder, the bidding documents (with owner's and GC's signatures on documents where needed, and blank forms in Division 00 completed) become the contract documents. The contract documents may also include modifications to owner-GC contract after the execution of the original contract. These modifications must be mutually agreed to between the owner and the GC per contract modification procedure described in Division 01. The items included in contract documents are shown in Figure 1.11, which also illustrates the differences between construction documents, bidding documents, and contract documents.

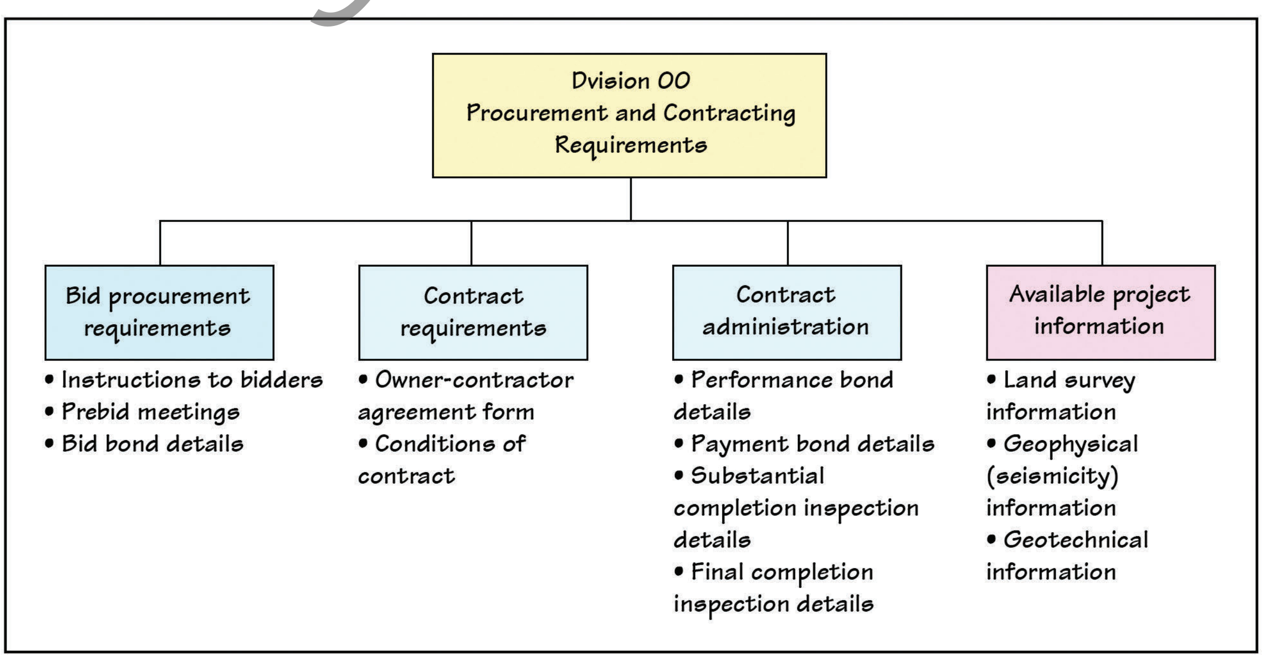


FIGURE 1.10 Important contents of MasterFormat Division 00.

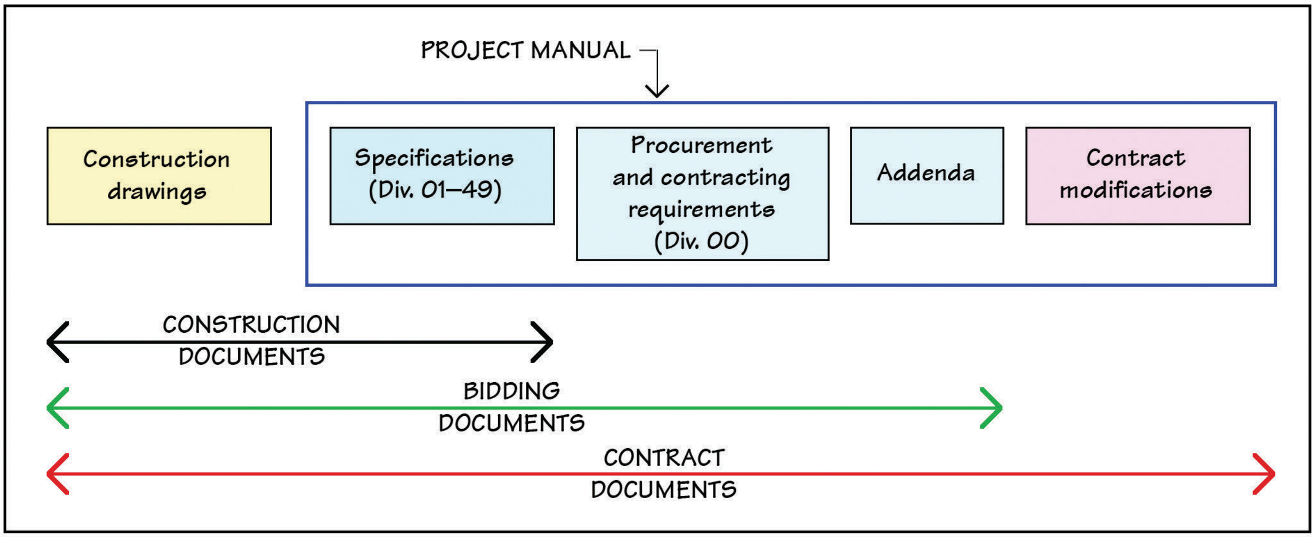


FIGURE 1.11 Differences among construction documents, bidding documents (also called "bid package"), and contract documents.

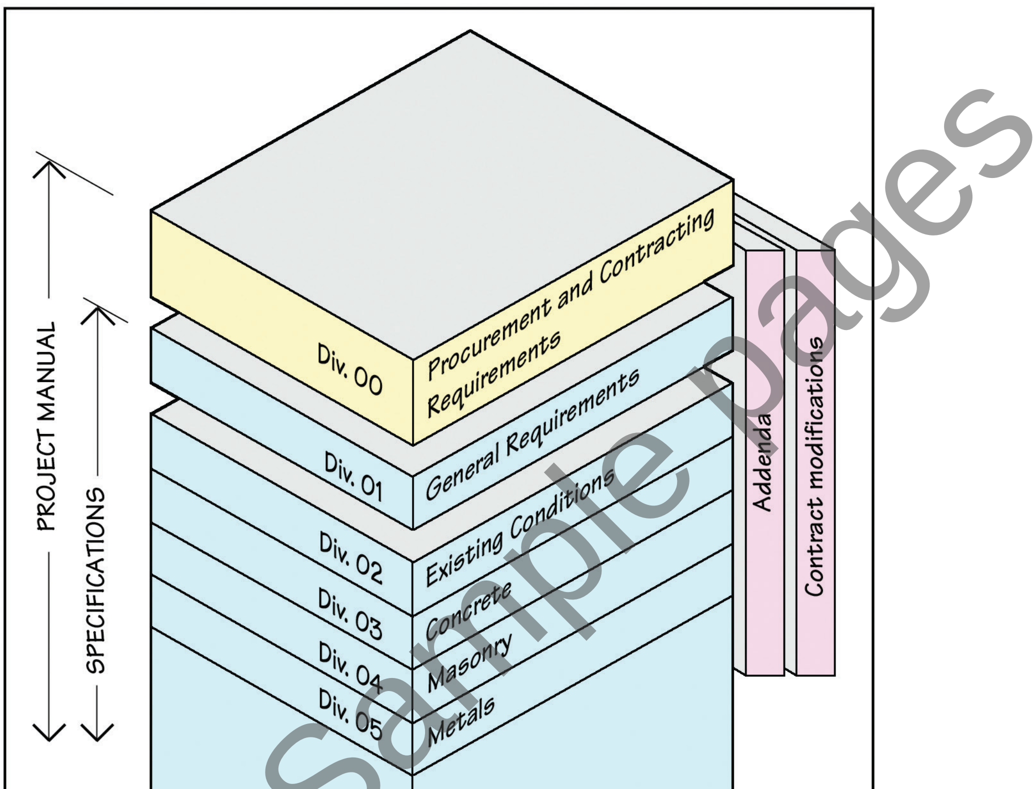


FIGURE 1.12 Contents of a typical project manual.

Although no owner would like to modify the contract, contract modifications are not uncommon. The reason, as stated in the introduction to this chapter, is that the construction of a typical building, unlike a manufactured product, is one-off entity, which may be subjected to unforeseen situations. Causes such as significant change in project scope (additive or deductive), design error or omission, nonavailability of materials due to national emegency, and extreme weather conditions may require contract modification.

Project Manual

Project specifications (Division 01 to 49), Division 00, addenda, and contract modifications are bound together into a document called the *project manual*, Figure 1.12. In other words, the project manual comprises the contract documents minus the construction drawings.

1.8 PRECONSTRUCTION PHASE: THE SURETY BONDS

It is essential that the GCs bidding for the project are qualified by virtue of their financial resources and a successful record of contracting experience to undertake the project of the size and complexity of the owner's project. Therefore, a reliable and just process of screening the GCs must be used, which is achieved by requiring the GCs to provide bonds to the owner.

A bond is a form of surety, which ensures that if the GC fails to fulfill contractual obligations, there will be a financially sound third party—referred to as the *surety* (also called the *guarantor* or *bonding company*)—available to take over those unfulfilled obligations of the GC. The bond is, therefore, a form of insurance that the GC buys from a surety—a bonding company.

There are three types of surety bonds in most building projects. A few others may be required in some special projects. The three types of bonds are: (i) bid bond, (ii) performance bond, and (iii) payment bond, each with a unique purpose, as described hereunder, and illustrated in Figure 1.13.

BID BOND

The purpose of the bid bond (also called the *bid security bond*) is to exclude frivolous bidders. It ensures that, if selected by the owner, the bidder (GC) will be able to enter into a contract with the owner based on the bidding requirements, and that the bidder will be able to obtain performance and payment bonds from an acceptable bonding company.

A bid bond is required at the time the GC submits the bid for the project. If the GC refuses to enter into an agreement or is unable to provide the required performance and payment bonds, the bonding company is obliged to pay a penalty (bid security amount) to the owner—usually between 5% and 10% of the project's anticipated cost.

PERFORMANCE BOND

The performance bond is required by the owner before entering into an agreement with the successful GC. The performance bond ensures that if, after the award of the contract, the GC is unable to perform the work as required by the contract documents, the bonding company will provide sufficient funds for the completion of the project.

A performance bond protects the owner against default by the GC or by those for whose work the GC is responsible, such as the subcontractors. For that reason, the GC will generally require a performance bond from all major subcontractors.

PAYMENT BOND

A payment bond (also referred to as a *labor and materials bond*) ensures that those providing labor, services, and materials for the project—such as the subcontractors and material suppliers—will be paid by the GC. In the absence of the payment bond, the owner may be held liable to those subcontractors and material suppliers whose services and materials have been invested in the project. This liability exists even if the owner has paid the GC for the work of these subcontractors and material suppliers.

PROS AND CONS OF BONDS

The bonds are generally mandated for a publicly funded project. In a private project, the owner may waive the bonds, particularly the bid bond. This saves the owner some money because although the cost of a bond (the premium) is paid by the GC, it is in reality paid by the owner since the GC adds the cost of the bond to the bid amount.

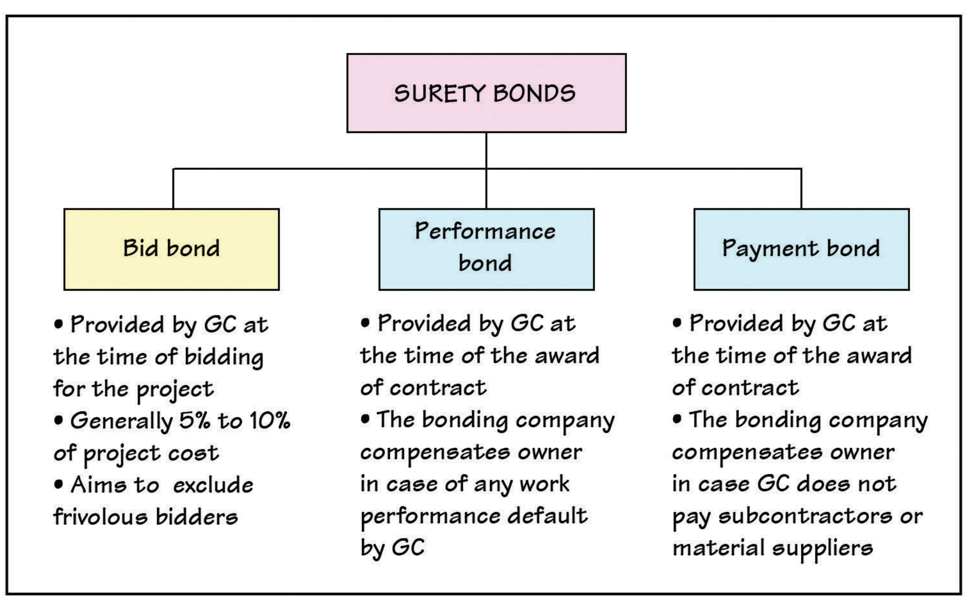


FIGURE 1.13 Details of three surety bonds used in construction projects.

Despite their cost, most owners consider the bonds (particularly the performance and payment bonds) a good value because they eliminate the financial risks of construction. The bid bond is unnecessary in an invitational bidding method where the owner knows the GC's financial standing and the ability to perform. However, where uncertainty exists, a bid bond provides an excellent prequalification screening of the GC. Responsible GCs and subcontractors generally maintain a close and continuous relationship with their bonding companies. Therefore, the bonding company's knowledge of a contractor's financial and contracting capabilities far exceeds that of most owners or architects (as the owner's representative).

1.9 PRECONSTRUCTION PHASE: SELECTING THE GENERAL CONTRACTOR AND PROJECT DELIVERY

After the bidding documents are ready, the selection of the GC is next obvious and a significant step forward. A number of selection methods exist. They differ from each other depending on:

a. the basis of selection—open competition, limited competition, or negotiation with selected GCs,
b. the timing of selection—stage of the project at which the selection is made—predesign phase, design phase, or preconstruction phase,
c. the GC's role during the design phase, and
d. the level of coordination between the design and construction teams through all phases of the project.

These methods are called the *project delivery methods*. Some of the most commonly used project delivery methods are:

- Design-bid-build (DBB) method
- Design-negotiate-build (DNB) method
- Construction manager at risk (CMAR) method
- Design-build (DB) method
- Integrated project delivery (IPD) method

The DBB is the oldest and most familiar method of project delivery. It has stood the test of time and enjoys the largest market share. The IPD is the latest method and still evolving in details with limited amount of industry consensus. Figure 1.14 gives the current approximate market shares of various methods [Refs. 1.2, 1.3], and the table "Project Delivery Methods at a Glance", at the end of this chapter, provides a synopsis of their pros and cons. The reader is urged to go through this table to obtain a bird's-eye view of various methods.

Regardless of the method selected, the essential features of construction and postconstruction phases are almost identical in all methods. Therefore, the activities involved in these two phases are covered first. In this coverage, we will assume that the GC has been selected and the construction has commenced. After the discussion of construction and postconstruction phases, the project delivery methods are covered in Sections 1.13 through 1.17.

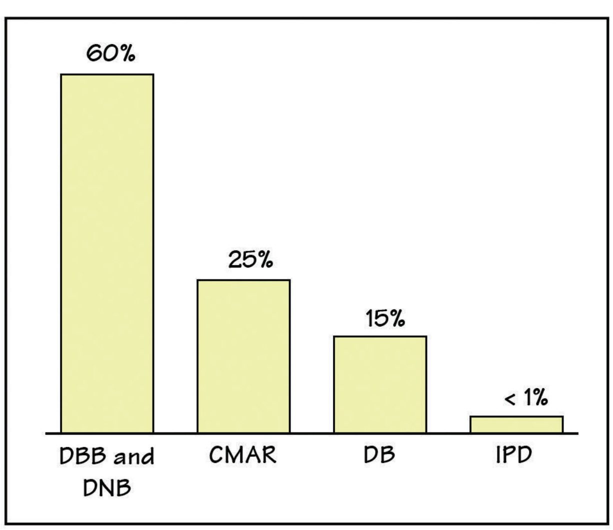


FIGURE 1.14 The current approximate market shares of various project delivery methods [Refs. 1.2, 1.3].

Each question has only one correct answer. Select the choice that best answers the question.

12. MasterFormat has been developed by the
- **a.** Construction Specifications Institute.
- **b.** American Society for Testing and Materials.
- **c.** American National Standards Institute.
- **d.** American Institute of Architects.
- **e.** Associated General Contractors of America.

13. MasterFormat consists of
- **a.** 20 divisions.
- **b.** 30 divisions.
- **c.** 40 divisions.
- **d.** 50 divisions.
- **e.** none of the above.

14. In MasterFormat, Division 02 refers to
- **a.** Procurement and Contracting Requirements.
- **b.** General Requirements.
- **c.** Masonry.
- **d.** Metals.
- **e.** none of the above.

15. In MasterFormat, Division 04 refers to
- **a.** General Requirements.
- **b.** Existing Conditions.
- **c.** Masonry.
- **d.** Metals.
- **e.** none of the above.

16. In MasterFormat, windows are part of
- **a.** Division 04.
- **b.** Division 05.
- **c.** Division 06.
- **d.** Division 07.
- **e.** none of the above.

17. In MasterFormat, roofing is part of
- **a.** Division 07.
- **b.** Division 08.
- **c.** Division 09.
- **d.** Division 10.
- **e.** Division 11.

18. In MasterFormat, flooring is part of
- **a.** Division 05.
- **b.** Division 06.
- **c.** Division 07.
- **d.** Division 08.
- **e.** Division 09.

19. Who is responsible for ensuring the safety of workers on the construction site of a typical building project?
- **a.** The architect
- **b.** The structural engineer
- **c.** The general contractor
- **d.** Occupation Safety and Health Administration of the U.S. Government
- **e.** All of the above collectively

20. The bidding documents include
- **a.** construction drawings.
- **b.** construction drawings and specifications.
- **c.** construction drawings, specifications, and addenda.
- **d.** construction drawings, specifications, addenda, and contract modifications.
- **e.** none of the above.

21. A contract document set consists of
- **a.** construction drawings.
- **b.** construction drawings and specifications.
- **c.** construction drawings, specifications, and addenda.
- **d.** construction drawings, specifications, addenda, and contract modifications.
- **e.** none of the above.

22. The project manual includes the project's construction drawings.
- **a.** True
- **b.** False

23. The surety bonds used in a typical construction contract are
- **a.** bid bond, contract award bond, and completion bond.
- **b.** prescreening bond, award bond, and completion bond.
- **c.** bid bond, performance bond, and completion bond.
- **d.** bid bond, performance bond, and payment bond.
- **e.** none of the above.

24. All required surety bonds must be provided by the GCs, who are bidding for the project, along with their bids, that is, at the time of bidding.
- **a.** True
- **b.** False

25. The owner is required to provide payment bond to GC whose bid has been accepted
- **a.** at the time of executing the owner-GC agreement.
- **b.** when the owner gives the notice to GC to proceed with the work.
- **c.** within one week of the GC commencing construction.
- **d.** when the GC provides performance bond to the owner.
- **e.** none of the above.

26. A GC would usually require performance bond from
- **a.** the owner.
- **b.** the architect.
- **c.** the owner and the architect.
- **d.** the owner, architect, and the consultants.
- **e.** each major subcontractor.

27. Where the owner is sufficiently familiar and confident of the financial and contractual capabilities of the GCs bidding for the project, the owner may not require the bid bond. This reduces the total cost of construction.
- **a.** True
- **b.** False

28. Of the various project delivery methods described in the text, the oldest method is
- **a.** integrated project delivery (IPD) method.
- **b.** construction manger at risk (CMAR) method.
- **c.** design-build method (DB) method.
- **d.** design-negotiate-build (DNB) method.
- **e.** design-bid-build (DBB) method.

1.10 CONSTRUCTION PHASE: SUBMITTALS AND CONSTRUCTION PROGRESS DOCUMENTATION

The construction phase begins after the GC has been selected, contract awarded, and "notice to proceed" has been issued. The selection of a GC is a function of the chosen project delivery method. Regardless of the chosen project delivery method, the role of GC in the construction phase remains essentially the same in all of them, and the GC must conform to the work described in the contract documents.

In preparing the contract documents, the design team's aim is to communicate the design intent effectively in order to minimize missing pieces of information. However, in almost every project, there are a few items that cannot be described to absolute finality in contract documents. For these items, the design team makes its final decision based on the information sought from the GC. The entities from which the required information is obtained are called *submittals*. Typical submittals include material and product samples, product performance data, shop drawings, and mockups.

Shop Drawings

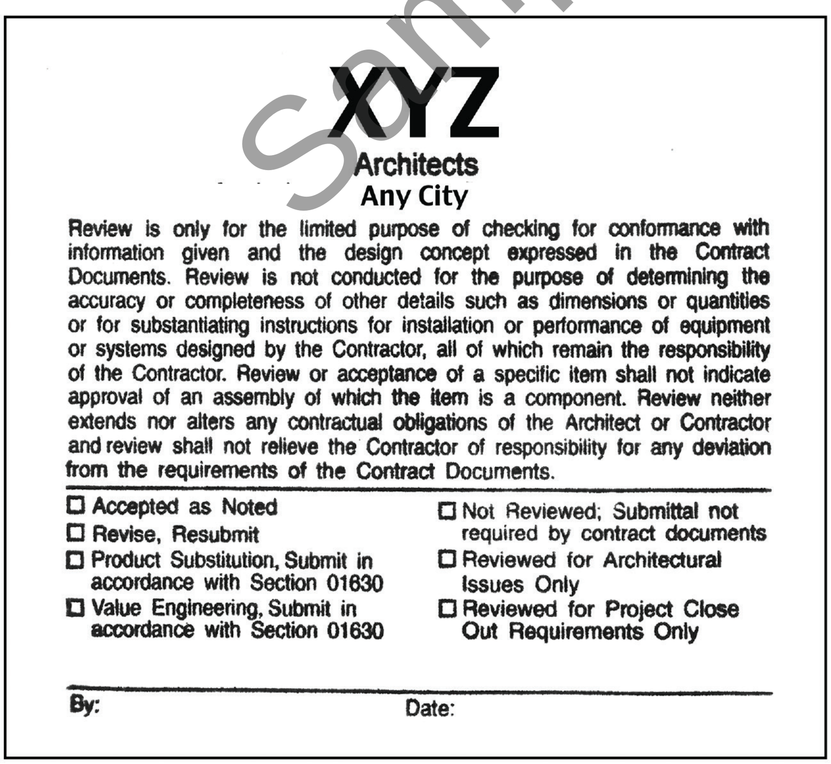
Shop drawings are required for components and products that must typically be made off-site (in a fabrication "workshop"). The need for shop drawings for certain items arises because the construction drawings do not describe them to a level of detail that makes their fabrication possible. Therefore, the fabricators generate their own drawings, referred to as *shop drawings*, to provide the higher level of detail necessary to fabricate and assemble the components.

Shop drawings are not generic, consisting of manufacturers' or suppliers' catalogs, but are exclusively prepared for the project by the manufacturer, fabricator, erector, or subcontractors. Shop drawings are a big item for structural members, such as steel columns, steel beams, and reinforcement details in reinforced concrete members. They are also required for nonstructural components. For example, an aluminum window manufacturer must produce shop drawings to show that the required windows conform with the construction drawings and the specifications. Similarly, precast concrete panels, stone cladding, and marble or granite floor coverings require shop drawings before they are fabricated and installed.

Before commencing fabrication, the subcontractors and suppliers submit the shop drawings to the GC. The GC reviews them, marks them "approved", if appropriate, and then submits them to the architect for review and approval. Subcontractors or suppliers cannot submit shop drawings directly to the architect.

The review of all shop drawings is coordinated through the architect, even though they may actually be reviewed in detail by the appropriate consultant. Thus, the shop drawings pertaining to structural components are sent to the architect and then to the structural consultant for review and approval. The subcontractor or supplier generally begins fabrication only after receiving the architect's review of the shop drawings.

The review of shop drawings by the architect is limited to checking that the work indicated therein conforms with the overall design intent shown in the contract documents, Figure 1.15. Approval of shop drawings that are later discovered to deviate from the contract documents



XYZ
Architects
Any City

Review is only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Review is not conducted for the purpose of determining the accuracy or completeness of other details such as dimensions or quantities or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor. Review or acceptance of a specific item shall not indicate approval of an assembly of which the item is a component. Review neither extends nor alters any contractual obligations of the Architect or Contractor and review shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents.

- ☐ Accepted as Noted
- ☐ Revise, Resubmit
- ☐ Product Substitution, Submit in accordance with Section 01630
- ☐ Value Engineering, Submit in accordance with Section 01630
- ☐ Not Reviewed; Submittal not required by contract documents
- ☐ Reviewed for Architectural Issues Only
- ☐ Reviewed for Project Close Out Requirements Only

By: Date:

FIGURE 1.15 A typical stamp used by architects to indicate the result of review of shop drawings and other submittals.

FIGURE 1.16 A typical mockup showing various finishes on the exterior facade of a building under construction. The workmanship in the finished building will be evaluated to match that of the approved mockup.

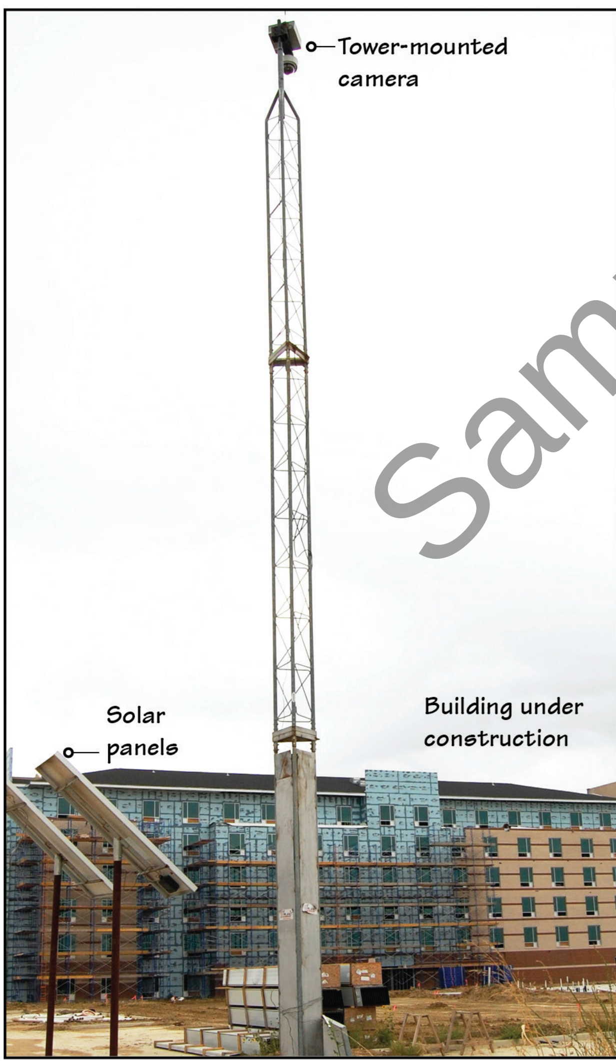


FIGURE 1.17 A tower-mounted camera takes regular photographs of the construction of the building shown. The solar panels power an array of batteries that, in turn, power the camera. The batteries are housed in a box below the panels, not visible in the photograph.

does not absolve the GC of the responsibility to comply with the contract documents for quality of materials, workmanship, or the dimensions of the fabricated components.

Mockups

In addition to shop drawings, full-size mockups of one or more critical elements of the building may be required in some projects. This is done to establish the quality of materials and workmanship by which the completed work will be judged. For example, it is quite common for the architect to ask for the construction of a mockup that shows various exterior façade materials before undertaking the construction of the actual façade. Figure 1.16 shows a typical mockup of a building under construction. In some cases, the architect may require mockups of the same façade utilizing different materials, different colors, or different features to make the final design decision (see Figure 29.20).

Construction Progress Documentation

Keeping a complete and continuous documentation of construction is an essential part of a GC's work. Important documentation includes project correspondence, minutes of meetings, verbal conversations, weather conditions, change order logs, critical materials brought to the site, and site visits by third party (design team members, building inspection personnel from the city, OSHA staff, etc.). (OSHA is an acronym for Occupational Safety and Health Administration of the U.S. Government.)

In many contemporary projects, the owner requires the GC to install web-based cameras (webcam) on the site for a continuous, photographic documentation of construction progress, Figure 1.17. This digital imagery provides real-time (24 × 7) and remote access of construction progress to the owner and the design team, in addition to time-lapse videos if needed. Modern webcam technology provides high-resolution images that help detect breach of site safety conditions, theft of materials, and such other activities. Images of construction obtained through drones and helicopters are also common, but they do not provide continuous documentation.