

LYP White Paper Series:

Library Stacks & Shelving

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1. INTRODUCTION TO LIBRARY SHELVING

There are as many varieties of library stacks and shelving as there are materials that sit on the shelves. Since bookstacks can occupy over 50% of a library's space, careful planning for shelving can be a large part of a library building project. Bookstacks are available that are single-faced or double-faced, high or low, deep or shallow, and cantilever-style or case-style. The components and accessories include end panels, canopy tops, sloped shelves, slotted divider shelves, display shelves, and retractable index shelves. The parts and pieces required for installation include bolts, bases, gussets, and struts. Unraveling the details of stack planning can be a complicated and time-consuming task but this is an area where the librarians will want to be involved in the decision-making. Library planners are cautioned to make their lists (and check it twice) to avoid the possibility of opening a library without enough shelving.

2. PLANNING FOR COLLECTIONS

One of the keys to the success of any library project is to provide enough shelving to meet the requirements for planned collections. There are various ways of calculating the shelving requirements for a project, ranging from using a simple mathematical calculation based on an average number of volumes per shelving unit to using sophisticated software applications, such as Libris Design, which will calculate the shelving requirements on a collection-by-collection basis.

To plan the shelving for a project, a number of decisions must be made once the size of the planned collections has been determined. These decisions should be made during the programming phase in order to allocate enough space in the building for collections. The criteria which determine the number of bookstack units and the space required include: shelf capacity or number of volumes per shelf, shelf depth, stack height and/or number of shelves per unit, selection of single or double-faced shelving units, and aisle width.

The width, depth and aisle requirement for the stack unit will determine the footprint or amount of space required for each stack unit. The net square footage allocated for each shelving unit is the amount of space that is necessary to house the shelving unit plus space in front of the unit for a person to stand. The net square footage typically includes regular (side) aisle space, which is shared with the adjacent shelving unit and an allotment of space for main and end aisles. Space allocation for single-faced units ranges from 10 to 14 square feet per unit and for double-faced units, from 18 to 22 square feet.

The number of stack units required will be determined by the size of the collections divided by the capacity per unit. For example: if the capacity for fiction volumes is 336 volumes per full height double-faced unit and the on-shelf collection size is projected at 3,360 volumes, then the number of stack units required will be ten. The total collection space required will be the sum of the space requirement for each individual collection. This equation is the number of units required x net square footage per unit = stack area required. The space requirement for fiction collection of 3,360 volumes is:

$$10 \text{ (units)} \times 18 \text{ (square feet per unit)} = 180 \text{ (assignable square feet)}$$

2.1 Capacity

Capacity is defined as the number of volumes capable of being shelved on a linear foot of shelf. The horizontal running length of a shelf is its linear length or width. A typical standard 3' wide section of shelving has shelves that provide three linear feet of storage per shelf. Typically, the published capacity for a collection (Charts I, II, III) will use volume numbers that will produce 25% of excess space per shelf. The shelves will not be full using these calculations. Optimum capacity for a working collection requires shelves that are only 70 to 75% full. This extra space is not considered future growth space, but is the space required for collection management, efficient reshelving, interfiling of new acquisitions and multi-volume sets.

The capacity per shelving unit will vary based on the collection being housed. The factors involved in determining the capacity are volumes per linear foot (by collection type) and number of shelves per shelving unit. Capacity of a shelving section is then an arithmetic calculation of volumes per foot x shelf length (width) x number of shelves. A 90" high x 36" wide, single-faced shelving section, consisting of one base and six adjustable shelves would have a total of seven shelves. The equation illustrating the capacity for fiction books at eight volumes per linear foot housed on a single-faced shelving unit is:

$$8 \text{ (volumes per linear foot)} \times 3 \text{ (linear feet)} \times 7 \text{ (shelves)} = 168 \text{ (volumes)}$$

The charts below provide some guidelines to use in determining the number of volumes per linear foot and the recommended shelf depth for the most common collections.

Cantilever-style Steel Shelving Capacity Schedule for Common Multimedia		
Media Type	Shelf Depth	Units per Linear Foot of Shelf
Audio Cassette	8 to 10"	19
Audio Compact Disc (CD) CD-ROM & DVD	8 to 10"	30
Audio book Cassette	10"	10
Media Kit (Audio Cassette w/Book)	10"	20
Video Cassette	10"	10
Current Magazines	12"	1
Current Newspapers	12"	1

Chart I: Capacity Schedule for Common Multimedia

Cantilever-style Steel Shelving Capacity Schedule for Children's Print Materials		
Volume Type	Recommended Nominal Shelf Depth	Volumes Per Linear Foot of Shelf
Children's Biography	10"	20
Children's Easy Readers	10"	20
Children's Picture Books	12"	20
Children's Reference	12"	8
Children's Spanish Language Picture Books	12"	33
Juvenile Biography	10"	16
Juvenile Fiction	10"	13
Juvenile Non-Fiction	12"	13
Juvenile Paperbacks	8 to 10"	16
Juvenile Spanish Language	10"	20
Juvenile Spanish Language Fiction	10"	15
Juvenile Spanish Language Non-Fiction	12"	24
Juvenile Spanish Language Paperback	8 to 10"	30

Chart II: Capacity Schedule for Children's Print Materials

Cantilever-style Steel Shelving Capacity Schedule for Common Print Materials		
Volume Type	Recommended Nominal Depth	Volumes Per Linear Foot of Shelf
Encyclopedias	12"	6
Legal	12"	7
Medical	12"	5
Public Documents	12"	5
Reference & Ready Reference	12"	6
Technical & Scientific	12"	6
Telephone Books	12"	5
Textbooks	12"	8
Fiction	10"	8
Careers	10"	6
Civil Service	12"	10
Classics	10"	8
Genealogy	12"	12
Large Print	10"	8
Literacy	10"	24
Local History	12"	8
Non-Fiction (Adult & Juvenile)	12"	10
Paperbacks	8 to 10"	16
Spanish Language Fiction	10"	17
Spanish Language Non-Fiction	10"	8
Cliff Notes	10"	35
Young Adult	10"	12
Young Adult Paperbacks	8 to 10"	16

Chart III: Capacity Schedule for Common Print Materials

2.2 Shelving Height

One of the most critical decisions to be made in planning for shelving is the height of the stack unit. The height of the unit will determine the number of shelves per unit, which, in turn, will determine the capacity for each unit and the number of units required to house the planned collections.

Manufacturers offer shelving units in various heights. The most common standard heights are 42", 66", 78", 84" or 90" high. This height refers to the height of the vertical (upright) component of the shelving unit. Units hold from two to seven shelves per side for storing collections. Other *non-standard* heights including 36", 45" and 60" are also available. Frequently 60" high units are substituted for 66" high units to exempt the units from the seismic requirements in the State of California which refer specifically to units *over 60"*. (See Section 5)

The height of the shelving selected will depend on the type of material housed. Younger children's materials are typically shelved on 42" and 66" high units and adult and young adult materials are typically housed on higher units. The shelving height selected will vary from library to library and often depending on the requirements for supervision of a particular area with shelving over 66" high blocking sight lines. In specific cases accessibility requirements will affect the height of the shelving selected.

Volume Type	Recommended Unit Height
Reference	66"
Reference (High and Low)	42"/90"
Adult Fiction	90"
Adult Non-Fiction	90"
Children's Picture Books	42"
Easy Readers	42"
Juvenile Fiction/Non-Fiction	66"
Young Adult	66"
Large Print	66"/78"
Current Periodicals	45"/66"

Chart IV: Recommended Shelving Height for Common Print Collections

2.2.1 Accessibility

Shelving height in most collection areas is unrestricted unless an attendant will not be available, and then it is limited to 54" above the finished floor. The exception is current periodicals, which must be accessible with a maximum side reach of 54" above the finished floor (48" preferred), and a front reach of no more than 48" above the finished floor. To accommodate this reach, shelving units can be no higher than 66" inches, or three sloped display shelves high. Additionally, collections such as the large print collection should reflect the physical challenges of the elderly and the visually impaired, with shelving that is not too high or too low. Heavier materials such as automotive repair manuals, oversized books, or telephone books might also be shelved on lower units.

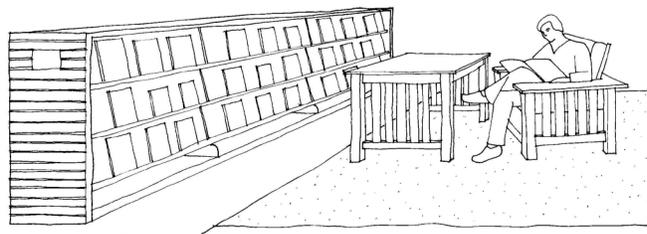


Illustration I: Low periodical display shelves with canopy top and end panel.

2.3 Shelving Depth

Along with the width and aisle requirements, the shelving depth will determine the footprint or amount of space required for each stack unit. Since stack units are available in various depths, library planners must select the proper size shelf for the materials being stored. (See Charts I, II, and III above.)

- Flat bookshelves 8" deep are still available as standard, but are virtually never used.
- Most collections can be accommodated on a flat 10" deep bookshelf.
- The use of a 12" deep shelf is common for reference, technical or scientific collections and pre-school collections, where some substitution of a 12" divider-type shelf is desirable.
- Periodical display shelving is always designed as being a minimum of 12" deep due to the use of a 12" deep flat shelf for back issue storage.
- Most manufacturers will have available a 16" deep shelf section, which has application for oversize book storage, but may be used for flat newspaper storage, or may be outfitted with hinged periodical display shelves on a 16" deep flat storage shelf for extra deep back issue storage facilities.

2.4 Stack Aisle Requirements

In addition to the width and depth of the shelving, the aisle allowance is the third determining factor in the amount of space allocated for each stack unit. Stack aisles are pedestrian paths located in stack areas. Stack aisles include Main Aisles, Side Aisles, Range Aisles, and End Aisles. Aisle requirements for libraries in California are found in Section 1106B.6 of Part II of Title 24 of the California Code of Regulations. (1998 CBC Section 1004.3.2.1)

- **Cross aisles** that run parallel to the stack aisles, which are intended to break up the side aisles into increments, are also known as range aisles. These are required to be 36” wide to meet accessibility requirements.
- **End aisles** run perpendicular to side aisles and may have books on one side. These must also be a minimum of 36” wide; 44” is required in some cases.
- **Main aisles** are those aisles, which are the principle accessible routes, and must be a minimum of 44” wide in California.

2.4.1 Stack Aisles and the Americans with Disabilities Act

Aisles in stack areas must comply with accessibility requirements. Side aisles, which run parallel to stack sections, can be no longer than 20 to 21 feet (6 to 7 stack sections) without a cross aisle (range aisle) provided to break up the side aisles. Both side and range aisles are required to be 36” wide. Main aisles are principle access routes which run perpendicular to side aisles and must be a minimum of 44” wide. End aisles run perpendicular to side aisles and must be a minimum of 36” wide. They can serve a single-faced section of stacks and in certain instances 44” may be required. Range and side aisles in magazine and other display area must be a minimum of 44” wide.

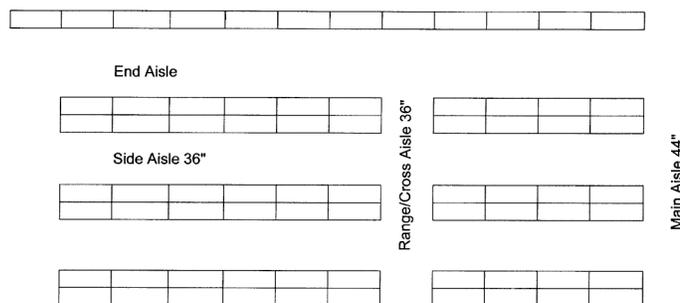


Illustration II: Minimum aisle requirements in the State of California

2.4.2 Stack Aisles and Column Spacing

In addition to planning the space required to house collections, determining the aisle requirements early in the project can provide valuable information to the architect and structural engineer. The stack aisle requirement and the column spacing should be coordinated to create a satisfactory stack layout. Without this advance coordination valuable space can be lost when aisles are blocked or valuable stack units lost to unexpected columns. In planning the structural requirements, a bay or module is the space between four columns and with good planning this dimension should equal some multiple of the stack unit width and the shelving aisle requirement.

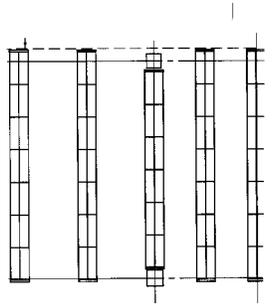


Illustration III: Shelving layout coordinated with columns

A 2' base shelf with a 3' aisle requirement would indicate an ideal column bay of some multiple of 5' in at least one direction. This would typically be a distance of 25' from one column to another. Including the column dimensions for a 6" square column, the measurement is taken from mid-column to mid-column to produce an ideal module of 25'6". If 4' aisles are requested, then the column bay would be based on a 6' module and 24'6" or 30'6" might be the ideal module. The dimension in the other direction might be based on multiples of 3' with a 6" column at the end of every 5th or 6th range depending on the structural requirements of the facility.

2.5 Single-Faced or Double-Faced

The decision to use single-faced or double-faced units is usually a design decision made when the furniture, equipment, and shelving are being drawn onto the floor plans. Occasionally libraries will require that certain collections, such as genre fiction, be housed on perimeter shelving, thus requiring single-faced units. Unless called out for a specific reason, this decision can be deferred until the schematic design phase and units can be calculated in either single-faced or double-faced equivalents. The only advantage to specifying double-faced units is that in a normal design condition, there can be a slightly more efficient use of space when double-faced units are utilized.

3. SHELVING TYPES

3.1 Cantilever-style Steel Shelving

Cantilever-style, or bracket, steel shelving systems are the most widely used book shelving and multimedia storage and display. This type of shelving, when installed to meet California seismic standards is very strong, very flexible, and the most economical solution for library shelving. The

individual components are manufactured of 16-gauge to 18-gauge cold rolled carbon steel sheet. Further detailed specification of these individual requirements is included in the Libris Design web article: *Furniture and Shelving: Specification and Bidding*.

Cantilever-style steel shelving uses a heavy-duty, slotted, vertical (upright) support column, supported by an appropriate load-bearing base structure, from which shelves can be bracket-attached to form single-faced or double-faced shelving units. The uprights have elongated holes or slots in one-inch increments to allow for the easy adjustment and relocation of the shelves. As standard, this type of shelving will not include a canopy top or end panels. Such items along with many other features are considered accessories to be specified separately. The base structure may be closed base or open base in its aesthetic detail.

Cantilever-style steel shelving is available as both single-faced and double-faced in a wide range of unit heights and depths. Standard width is generally 36", but 30" units can also be purchased. Standard heights are 42", 66", 78", 84" or 90", but custom heights can be fabricated by changing the dimension of the vertical support column.

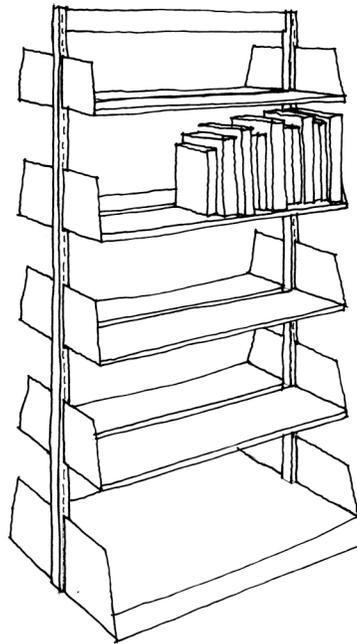


Illustration IV: Double-faced steel cantilever-style shelving unit

3.1.1 Cantilever-style Shelf Dimensions

Shelf depth is typically described as a *nominal* dimension and shelving height and width are typically described as an *actual* dimension. Because the structural framework is an open-centered frame, in most cases, 2" deep, a 2" void exists behind the adjustable shelves. To calculate shelf depths, the centerline of this void (1" deep) is considered the rear edge line of the shelf space. In

its definition, a shelving section would be specified to have a nominal 10" deep shelf, for example. In fact, the shelf itself if measured with a tape measure is actually 9" deep, with 1" of the rear void attributed to shelf depth, thus totalling 10" deep. This concept applies whether single-faced or double-faced construction.

In the case of single-faced shelving, there will actually be the full 2" deep void into which materials can penetrate. This translates into an actual 9" deep shelf producing 11" of storage depth. Again, this 2" void space seems like "found" space, and it affords flexibility in shelving odd-sized or some oversized materials.

The exception to this is slotted divider type shelves. Since the adjustable dividers require a high back edge on the shelf for engagement, the divider shelf, when described as being nominally 12" deep, would be actually 11" deep due to the loss of access into the void space.

The disadvantage of this void space is that books are often carelessly pushed back into this void, with the potential for small books to become dislodged, falling down into the void. To overcome this, there are two options:

- **Option #1:** Substitute an integral back-style shelf for the standard flat shelf. The integral back shelf has an "upturned" lip along the rear edge, resulting in the net actual depth of the shelf being the total storage depth.
- **Option #2:** Add a shelf space backstop accessory, which hooks into the frame above the flat shelf surface, thereby resulting in the net actual depth of the shelf being the total storage depth.

3.1.2 Cantilever-style shelving – Components & Options

3.1.2.1 Base Shelves

The impact of this 2" frame void carries into the base shelf as well. Most manufacturers produce a one-piece flat base shelf, which bridges the 2" void to produce a closed, flush shelf surface. In addition, the flat shelf usually will be of one-piece construction, including the toe kicks formed along outer edges. A manufacturer may choose to make a two-piece base shelf that butts against and is flush on the topside, with an infill piece 2" wide at the frame, providing an essentially flush base assembly. An integral back type base shelf becomes a two-piece base, and the upturned lip on the rear edge fits against the frame with the open void left inside the frames at the bottom.

3.1.2.2 Optional Sloped Base Shelf

Sloped base shelves serve the purpose of canting the books such that the spine titles and call number can be more easily read. Most manufacturers offer an optional two-piece sloped base shelf that also fits flat against the frame face leaving a void in the frame opening at the bottom.

Some manufacturers construct their base assemblies using a flat base shelf component used in conjunction with a mechanically attached toe kick as a separate piece. Regardless of the design used, a closed base shelving system always provides the benefit of concealing all attaching brackets and anchoring hardware that are a necessity in California shelving installations.

3.1.2.3 Canopy Tops

Other than on case-style shelving where a canopy top is integral to the structure, this component is an accessory. A canopy top is a finish detail available for stack sections of all heights. Typically canopy tops are specified for sections under 72" in height, or below eye level, but they can be used for units of all sizes. The canopy top can be used as an additional worksurface, storage shelf, as a means of keeping the collection dust free, and as a means of producing a limited amount of added strength to the shelving range. Canopy tops are available in a variety of materials, including laminated particleboard, solid wood or metal, with unlimited options available in color and finish material. Typically the architect or interior designer specifies the finish material for canopy tops as part of the design process.

The preferred style of canopy top is one which is made as a one-piece special component which completely covers the top of the supporting structure, and is designed to have a good size dropped edge fascia along the front edge. This achieves as close to a flush-enclosed top as possible.

Some canopy tops are made up of parts which cantilever from the vertical columns, and butt against the top horizontal cross spreader of the structure. This style may not have the benefit of as large a dropped-edge fascia on the front edge.

3.1.2.4 End Panels

End panels, whether a structural part, such as on wood or metal case-style shelving, or, as a finished range end closure, on Cantilever-style shelving, are, as standard, very plain in appearance. In most library installations, a decorative end panel is applied on range ends to add a design element and likely, a functional feature where range signage can be applied.

Typically the architect or interior designer on the project would design these decorative end panels. There is usually a design scheme being followed which ties together the finest points in architectural millwork, the design statement followed through in furniture, and a related expression in the design of decorative end panels. Such end panels will be custom, and it is often advisable to include their manufacture as a millwork item from the Subcontractor on the job or, as an extension of the furniture contract from the supplier of the library furniture.

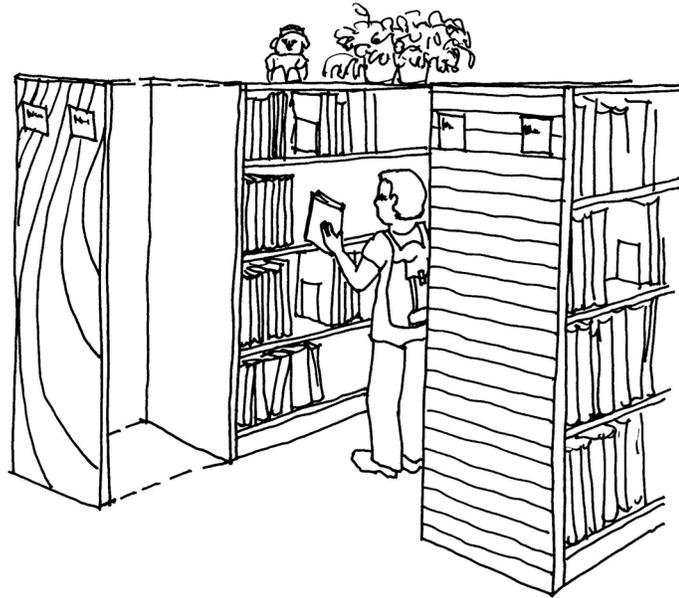


Illustration V: Shelving Unit with Decorative End Panels and Canopy Top

Decorative end panels might involve the use of furniture woods and veneers, laminates, or a combination that results in a need for furniture grade finishes. Such finishes vary with wood species and depend on color choices required, which is why decorative end panels are frequently considered to be furniture rather than shelving.

3.1.2.5 Filler Units

Frequently either the architectural design or the interior layout will require the use of filler units. These units are required to fill an architectural void, which is created when one of several conditions exists.

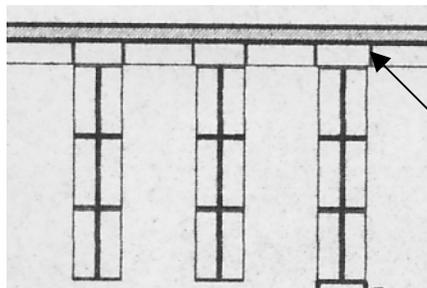


Illustration VI: Architectural void requiring intermediate filler unit.

Corner Fillers: When wall shelving ranges meet at an inside corner, a void is created. A two-sided, panel-type enclosure obscures this visually, and would be furnished with a top panel to prevent debris from getting inside the closed off void.

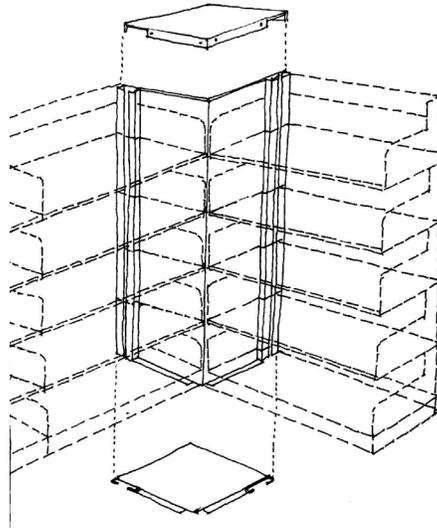


Illustration VII: Corner Filler Unit

Intermediate Filler: When a double-faced unit is placed perpendicular to a wall mounted single-faced shelving range, a large void occurs. A three-sided panel-type enclosure fills this void and receives the end of the double-faced shelving unit. It should have a top panel similar to that described above.

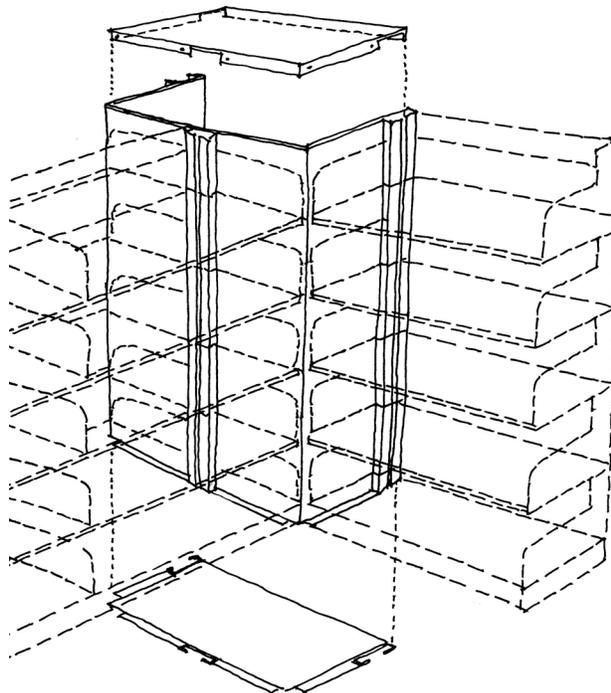


Illustration VIII: Intermediate Filler Unit

End Filler: When wall shelving ranges do not completely fill a wall area from end-to-end, it adds to the overall finished appearance of the installation if two-sided, panel-type enclosures are added at one or both ends of the range to obscure the void and close off the front and top of the opening.

These voids can be furred out and filled in with drywall and/or plaster by the general contractor instead of utilizing a fabricated piece provided by the shelving manufacturer to enclose the void.

3.1.3 Cantilever-style Shelving Accessories

3.1.3.1 Stack (range) Signage

Stack or range finding signage decisions should be made at the earliest planning stage. An interior designer who has responsibility for the furniture design and specification and the signage design would provide an added benefit in coordination. Sign manufacturers can produce custom designed and fabricated stack signage. Manufacturers offer range finder components and cardholders as accessories that can be attached to the end panels.

3.1.3.2 Multimedia Storage and Display Shelving

The broad diversity in multimedia materials makes their storage and display complicated. All shelving manufacturers offer several types of accessory shelves or other inserts such as browser bins and sliding trays which connect into their standard framework. It will be necessary for the library shelving specifier, knowing the nature of materials to be housed, to consult with the selected shelving vendor to determine the best possible solutions.

Planners should pay special attention to required shelving depths for multimedia shelving units which can range in depth from 6" to 16" for browsing bins. Further, it is critical to note that a full height unit may not be desirable, since patrons may prefer not to browse on the bottom shelf, or above eye level height. In cases where specific multimedia shelves are specified, decisions about the shelving height and depth are critical. These restrictions must be taken into consideration when calculating the number of stack sections required for multimedia units. In many cases, separate, freestanding furniture or display units specifically designed for media may prove to be superior solutions for the task, but they will not provide the flexibility of the Cantilever-style steel shelving unit.

3.1.3.3 Book Supports

The most popular type of book support is the plate-type book support. These are available in two heights (6" & 9") and are selected according to size of books or materials being shelved. The simplest design is one formed from sheet metal and is only the thickness of the metal material, which is approximately 1/16" thick. This style can be easily lost between books, or knifed inside of books as patrons re-shelve after browsing in the stacks.

A second plate-type book support design is manufactured as a stamped part. This is strong and durable and has the added design feature of folded "flanges" toward the outside. This creates a

support surface which is ¼"- ½" or more in thickness and is more easily findable when sandwiched between books which is why these are called *findable* book supports.

Findable book supports are also manufactured in molded plastic. These are less durable and will support less weight than the steel findable supports. All of the plate-type book supports have an add-on option of a cork-surfaced bottom. The cork surface increases the grip against the shelf while protecting the shelf from being damaged. These findable book supports are available from either the shelving vendor or from library product catalogs.

Wire-type book supports are another option available for cantilever-style shelving. The simplest is a formed wire bail, which is either long or short in the vertical dimension. This piece connects into the underside formed edges of the metal shelf. There is a similar formed bail that is attached by a compression fit into only one of the underside formed edges of the metal shelf above.

These two types of book supports hang from an upper shelf to support books or materials on the shelf below. Unless the topmost shelf in a section has a canopy top outfitted to receive the wire book support, one substitute plate-type support must be specified for each topmost shelf. These are the least popular type of book support as they frequently bend from the weight of the collections.

Many manufacturers of metal shelves provide an adjustable shelf option with an upturned edge at the back of the shelf or *integral back shelf*. A wire-type book support that has a connector for attaching and sliding along this raised edge is available for this type of metal shelving.

Some cantilever-style shelving includes a wire-type book support that attaches to and moves within a formed metal track that attaches to the shelving frame at the back of individual shelves.

3.1.3.4 Retractable Reference Shelves

Pullout reference shelves are available as an accessory option from manufacturers of metal shelving. They are provided as a convenience to patrons browsing in the reference bookstacks. These shelves are installed by being connected to the underside of an adjustable shelf, rather than attached to the shelving structural elements. It is important to critically evaluate the design and construction of this component, particularly as to the underside operable details where unfinished or sharp fabrication elements could result in damage to bookbindings or personal injury when accessing materials on the immediate shelf below.

3.1.3.5 Newspaper Shelves

The least popular method for display of newspapers is the old traditional wood newspaper sticks, which can hang into the shelving structure on special inclined brackets. The simplest display method is to stack the half-folded newspapers on a flat (minimum 12" deep) shelf. The most costly and most satisfactory method of display is to place the half-folded Newspaper on a typical

sloped periodical shelf having the J-shaped lip at the bottom, installed on lower sloped brackets. This would accommodate two or three editions per shelf, and the special installation instructions must be called out in written specifications. The ultimate enhancement is to equip the sloped shelf with a pair of hinged, clear acrylic (plastic) covers to hold down the individual newspapers displayed on the shelf.

3.1.3.6 Periodical Display Shelving

Periodical display shelving provides a display surface for current periodicals with back issue storage below. The display shelves are sloped and are either fixed in position or hinged to side brackets allowing them to be lifted for better access to the back issue storage shelf. All sloped shelves should have a J-shaped retaining lip at the bottom edge. This is generally standard on hinged-typed periodical shelves, but not generally standard on fixed-type periodical sloping display shelves. The J-shaped feature should be specifically called for on fixed-type periodical display shelves.

The J-shaped retaining lip feature allows for the installation of signage labels on the face of the upturned lip. An optional signage attachment fitting can be specified for this purpose.

3.1.3.7 Slotted Divider Shelves

Divider-type shelving is an optional accessory shelf, which comes with a number of adjustable vertical support members that fit into slots in the surface of the shelf. These metal dividers can be used to create contained compartments on the shelf area providing extra support for heavy use or larger format collections which might typically fall over; or they can provide space management to control storage space for items such as back issues of periodicals or telephone directories. These are most frequently used for picture books, small bound materials such as literacy materials, or heavy materials such as reference collections. These are among the most desirable types of shelves available, but the cost per individual unit makes extensive use cost prohibitive.

3.1.4 Top Tie Struts and Stack Lighting

Top tie struts are horizontal overhead beams that connect a bank of stack ranges. They are a manufactured accessory and are more widely used outside of Seismic Zones 3 and 4 than in the State of California. In these areas outside of California, top ties are used to add stability and eliminate shake due to the fact that sections are installed as truly freestanding stacks, having no internal added reinforcement and are not anchored in place. They do not meet the seismic requirements for Seismic Zone 4 and in some cases their use has been determined to be the cause of stack failure in a seismic event.

These top tie members are sometimes used as supports for bookstack aisle lighting fixtures. This approach to stack aisle lighting though very simplistic, has several shortcomings:

- The resultant installation usually lacks finesse in its aesthetic detail.
- Unless the light baffles are narrowly spaced there is the possibility that removal of a book from a top shelf can break the lamp.
- It leaves the fixture so low that, it does not adequately distribute light to the top row of shelves, and being so low, it allows exposure to tampering.

These points can be corrected by fabricating a riser structure above the shelving frames, onto which top tie members are attached, leaving the light fixture high enough to distribute light to the top shelf area, and placing fixtures out of normal reach.

3.1.4.1 Stack-mounted Light Fixtures

The incorporation of stack attached light fixtures is neither simple nor inexpensive in California seismic zones. The addition of such structures adds a weight load to the shelving systems, and impacts the structural engineering and design of reinforcement and installation. Because there is no standard solution to this problem, the architect or designer needs to carefully design the details to avoid an unsatisfactory installation.

Unless bookstack-supported lighting is the only design solution, this approach should be thoroughly analysed in comparison with strategically placed building lighting. While it takes coordination between building trades, the careful placement of pendant-supported fixtures can work well as aisle lighting.

3.1.4.2 Bookstack Aisle Lighting

Bookstack aisle lighting is typically a central aisle fixture distributing light to stack faces on both sides of an aisle. Once the bookstack space plan has been finalized, the services of a lighting consultant are essential in specifying the proper light fixture.

Many shelving manufacturers have standard light fixture accessories that hook into the shelving systems at the top of the support columns. These are cantilevered canopy-type assemblies which either function like display case lighting, or, others cantilever outward far enough to provide down light on the whole face of the section. These are expensive components, and one must use two of these accessories to light both faces of a double-faced stack section.

It is important to remember that whenever using any style of stack-supported lighting, that a number of electrical stub-in locations (rough-ins) must be accurately determined. Coordination of dimensioned drawings must take place between the shelving vendor and electrical contractor early on in the construction process, unless the architect accepts the responsibility of detailing these placements.

There are many issues related to stack lighting including the widely disagreed upon foot-candle requirement, the debate of direct and indirect lighting, and the pros and cons of parallel vs. perpendicular lighting installation. For a further discussion on library lighting and stack lights see the article “Lighting for Libraries” on the Libris Design website.

3.2 Case-style Shelving Products

Case-style shelving refers to any type of shelving system that uses a full panel, vertical component from floor to top with adjustable shelves or supports which engages at ends into these vertical panels. This style of shelving will always have a closed base shelf assembly, and a canopy top. Case-style shelving is available in plastic laminate on chip core or particleboard, wood or metal. Such shelving is constructed in single-faced and doubled-faced versions, and may be used with or without back panels however; if double-faced models are used without back panels, some longitudinal bracing members must be added.

Case-style shelving is generally considered to be finished in appearance, and, for that reason, is most frequently used in meeting rooms, workrooms or offices, where an aesthetics override the structural, cost or flexibility requirements. An architect or interior designer will typically specify such shelving for what is referred to as a *contract interior*.

When built-in case-style shelving is specified by a design professional for new or renovation construction, they will often refer to the shelving as casework or millwork. Millwork shelving would be described as being of wood material, or, plastic laminate material construction, and built by a custom-fabricator for specific application to the construction project. Specifications for millwork construction are taken from published standards in casework construction. These standards are available from the Architectural Woodworking Institute (www.awinet.org) or the Woodworking Institute of California (www.wichet.org). Under these standards, the shelving is considered to be a form of cabinet, and is built using general casework standards. These specifications would be published as part of the project construction specification document.

A review of the millwork shelving specifications should be made to insure that the adjustable shelf material provides load bearing strength to support a full shelf of books (approximately 100 pounds) without significant sagging. Library staff should also review the methods and hardware proposed for shelf adjustability for their practical use as well.

When case-style shelving is specified as a manufactured shelving system in either wood or metal, it will be published under a *Special Equipment* category in the project specifications, and the exact requirements for the product and its use will be published.

3.2.1 Manufactured Wood (Case-style) Shelving

Wood shelving systems, by furniture manufacturers, will be offered according to their printed product specifications. Products will vary, as with millwork shelving, and again, the most important component is the adjustable shelf. Traditionally, all quality manufacturers have offered

a solid hardwood lumber shelf, glued up in strips according to published woodworking standards. This produces a planked shelf that may or may not use the same hardwood species as that used for the case enclosure. The solid hardwood lumber aspect is critical. Adjustability is also important.



Illustration IX: Case-style shelving

Wood shelving products have evolved, in light of market competition, to being constructed more along the lines of custom millwork. The prime result of this move towards custom millwork is that shelf adjustability now tends to follow the 32mm spacing (1-1/4") that results from the use of European woodworking machinery. This spacing, fine for cabinetry, presents problems in efficient book shelving spacing. Specifiers and librarians should be alert to this nuance when evaluating products for potential use.

Wood library shelving systems, being a furniture manufacturer's product, will be offered in that manufacturer's standard wood species. These most likely are red oak or hard maple. When other wood species, such as walnut, cherry or ash are specified, the manufacturer applies price premiums that greatly increase the cost of wood shelving.

Manufactured, modular-shelving systems will have basic accessory options available, such as periodical display, newspaper stick display and divider-type shelves. Back panel options for this type of wood shelving can be of wood veneer plywood, or, painted hardboard. The back panel in double-faced shelving serves as a structural component as well; thus when double-faced sections are installed without back panels, an added longitudinal brace option must be installed.

3.2.2 Metal (Case-style) Shelving

Case-style metal modular shelving systems have become the least popular shelving type and are now available from only a few sources. The most important feature in metal case shelving is that the upright end panels are flat on the inside shelf space, thus eliminating the ribs that books can be jammed against, potentially breaking the bindings.

This type of shelving will have accessories for periodical display, divider-type shelves, retractable reference shelves and perhaps, newspaper display. The back panels in metal case-style shelving are also made of sheet metal and are not costly. In the installation of double-faced shelving, the back panel serves as a structural component as well as a separator between faces. Without the use of a back panel, an additional longitudinal brace must be added.

3.3 Compact Shelving Storage

Compact shelving, which is also referred to as High Density, Moveable Aisle or MAC shelving, is a shelving system that rides on moveable carriages over floor-installed rails. The rails can be either surface mounted or set in the concrete when the slab is poured. Compact shelving units are now available with both manual and electrically operated chassis and with safety devices which cause the movement of the carriage to stop if it makes contact with an object (book truck) or a human.

The benefit of compact shelving is to maximize use of floor space by having one access aisle, which is relocatable by moving the carriage mounted shelving to open an access aisle at a desired location. This arrangement can eliminate as many as five or six side aisles for an enormous space savings. By decreasing the aisle width requirement to one single relocatable accessible aisle, the amount of space required to house collections can be cut in one-half, at a minimum, and up to one-third for a larger installation. Because of the cost of the installation and the equipment, small installations are not recommended.

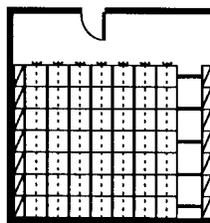


Illustration X: Compact Shelving Installation with single accessible aisle

The benefits of cantilever-style steel shelving as a strong yet flexible system is reinforced in its use on moveable carriages for compact shelving installations. In this context, a storage shelving system appropriate for that use is furnished on the moveable carriages. When specifying systems for library use (book shelving), it is specify the cantilever-style steel shelving rather than storage shelving, which a compact shelving vendor might otherwise be predisposed to recommend.

The installation of compact shelving requires advance planning if the rail upon which the carriages ride is to be imbedded in the concrete slab. This installation provides a smooth flat floor and the carpet can be installed right up to the edge of the rail. When the rail is installed later and surface mounted on the concrete slab, it will be necessary to create mini-ramps using plywood or other flooring material in order to provide a smooth, flat, and accessible path through the compact shelving units. Because of the increased load bearing requirements, the architect and structural engineers should be informed early in project of any planned or future compact shelving installation.

3.4 Multi-tier Stack Core

Multi-tier stack cores are specially-engineered and constructed steel shelving systems which are assembled as two or more tiers of shelving sections in which the upper level support members are integral to the stack system and separate from any building structural elements.

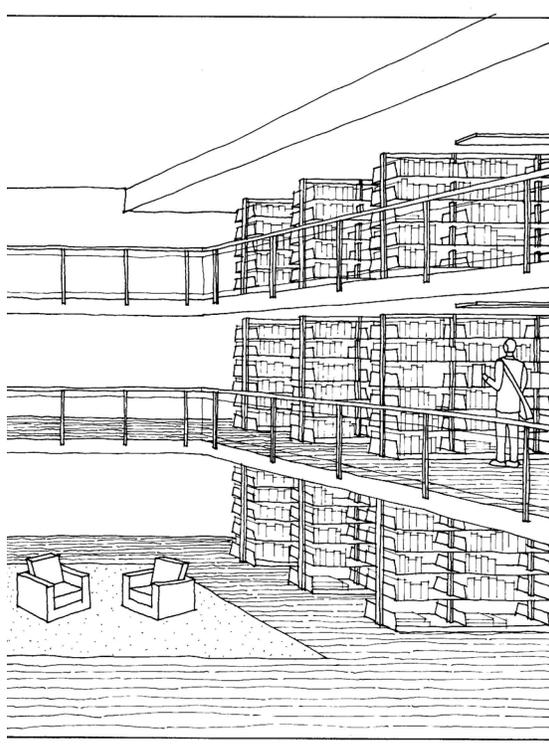


Illustration XI: Multi-tiered stack core.

Extremely popular a number of years ago, the system incorporates floors for upper level access aisles and stairwells for passage between tiers. Because of the extreme California seismic structural demands, this type of system is generally not used in California. This type of shelving construction can also present difficulty in meeting disabled access requirements due to narrower aisle widths. The low ceiling heights (typically 7'6" high) can make installation of fire sprinklers difficult as well.

An existing multi-stack tier can usually be *grand-fathered in* when a full update to current code is required, but the low ceiling heights and requirements of a multi-stop elevator will often make demolition a necessity.

4. BOOKSTACK DIMENSIONS

Manufacturers of wood library shelving follow a standard format of overall section heights and depths. The same is true for manufacturers of steel cantilever-style shelving; however, it is a different dimensional format from that adopted by wood shelving manufacturers. A critical difference between wood and steel shelving manufacturers occurs when dimensions are published.

- **Wood Shelving:** Industry-standard width for wood shelving section is: 36" wide. All other widths are generally considered custom widths, and are factory-manufactured to actual field dimensions and carry a price increase.
- **Cantilever-style Steel Shelving:** Industry-standard width for a steel shelving section is: 36" wide, with 30" and 24" wide widths available. It is very rare for a steel shelving manufacturer to factory-build shelving to custom widths.

4.1 Cantilever-style Steel Shelving Dimensions

Cantilever-style steel shelving manufacturers dimensions are considered to be nominal. A double-faced, Cantilever-style steel shelving that is described as "a section is 84" high x 24" deep" is, in fact, 84" in overall height, but actually somewhere close to 24-½" in depth. A single-faced, cantilever-style steel shelving that is described as "a section is 84" high x 12" deep" is, in fact, 84" in overall height, but actually somewhere close to 13-½" in depth.

When developing shelving space plans utilizing Cantilever-style steel shelving, this is a critical concept to master, especially where space is tight and one must struggle to maintain adequate legal and accessible aisles.

Growth is a dimension concept used in applying actual stack unit dimensions to actual plan layout and physical building spaces. Conceptually, growth is the factoring in of actual stack unit depths that are greater than published nominal dimensions, plus the growth in length of assembled ranges due to the insertion of reinforcing gussets between frames, as their thickness increases the length.

Often, architectural floor plans are drawn using nominal dimensions, therefore, it is important to realize that the aisle will be diminished in width by the amount of growth which results from factoring in the oversize actual shelving dimensions.

One should also add from ½" to 2" to the shelving width dimension when including decorative end panels at range ends, as aisle width will be determined by clearance between end panel edges at the entrance end of the aisle.

Cantilever-style Steel Shelving Dimensions				
Nominal (Published) Height	Actual Height	Nominal (Published) Unit Depth	Actual Unit Depth Single-faced	Actual Unit Depth Double-faced
42 /45"	42/45"	8"	9-3/8"	16-½"
		10"	11-3/8"	20-½"
		12"	13-3/8"	24-½"
		16"	17-3/8"	32-½"
66"	66"	8"	9-3/8"	16-½"
		10"	11-3/8"	20-½"
		12"	13-3/8"	24-½"
		16"	17-3/8"	32-½"
78"	78"	8"	9-3/8"	16-½"
		10"	11-3/8"	20-½"
		12"	13-3/8"	24-½"
		16"	17-3/8"	32-½"
84 or 90"	84 or 90"	8"	9-3/8"	16-½"
		10"	11-3/8"	20-½"
		12"	13-3/8"	24-½"
		16"	17-3/8"	32-½"

Chart V: Cantilever-style Steel Shelving Unit Dimensions

4.2 Wood Shelving Dimensions

Wood library shelving dimensions are considered to be actual dimensions. Wood shelving that is described as "a section is 82" high x 24" deep" are exactly, and actually, those overall height and depth dimensions.

Standard Wood Shelving Dimensions					
Overall Height	Actual Height	Overall Single - Faced Depth	Actual Single-Faced Depth	Overall Double-Faced Depth	Actual Double-Faced Depth
42"	42"	8"	8"	16"	16"
		10"	10"	20"	20"
		12"	12"	24"	24"
		16"	16"	32"	32"
60"	60"	8"	8"	16"	16"
		10"	10"	20"	20"
		12"	12"	24"	24"
		16"	16"	32"	32"
82"	82"	8"	8"	16"	16"
		10"	10"	20"	20"
		12"	12"	24"	24"
		16"	16"	32"	32"
96"	96"	8"	8"	16"	16"
		10"	10"	20"	20"
		12"	12"	24"	24"
		16"	16"	32"	32"

Chart VI: Wood Shelving Unit Dimensions

5. SEISMIC ISSUES

Due to the frequency and potential severity of seismic activity throughout the State of California, this study on the design, features, and use of shelving must accordingly address these seismic forces and their potential impact on both the construction and installation of library shelving.

The task of attempting to resist the vertical and lateral forces created in an earthquake requires structurally enhanced shelving structures and special anchoring procedures in installation. This requirement originates in the Uniform Building Code which identifies structural performance standards for any shelving over 5'-0" high. (See 1995 Uniform Building Code, and applicable California Amendments.)

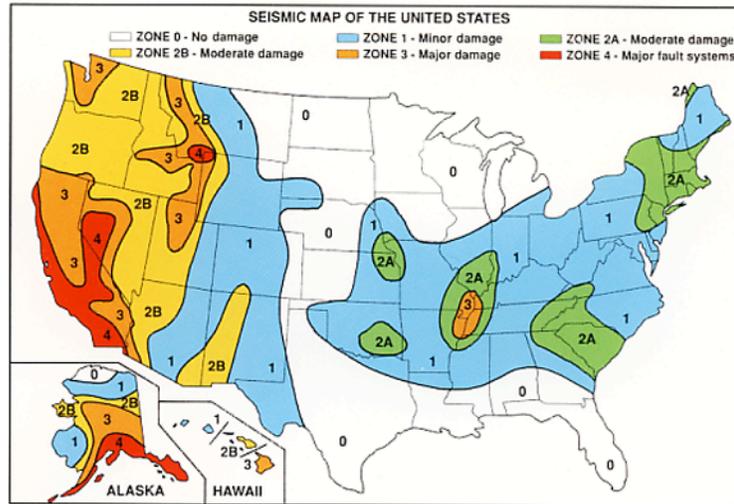


Illustration XII: Seismic Zone Map of United States

In seismic zones 2B-3-4, bolt type, 3/8" diameter sway braces are utilized, 1 pair every fourth section zone 2B; 1 pair every third section zone 3; and 1 pair every other section zone 4; a pyramidal shaped 13 gauge web stiffener 6" wide at bottom and 3" wide at the top, welded to base brackets and uprights 60" high and higher is utilized. Floor anchors, ICBO approved, are required. (See Illustration XIII below.)

Only in recent years have most shelving manufacturers fabricated the special reinforcing components needed to satisfy California Seismic Code compliance. These special components must be specifically ordered along with standard shelving structures, and are fitted into the assemblies at the time the shelving is installed. The installation process not only includes the assembly of such specially reinforced structures, but also the requirement to anchor all assemblies in place. In this process, wall shelving would be secured to some structural element in the walls at the tops of the sections, plus, floor anchored to resist vertical forces.

Freestanding, or island sections, usually double-faced, must be floor anchored. The anchoring hardware is heavy-duty, with specific size, content and insertion details determined by a structural engineering evaluation. The structural nature of cantilever-style steel shelving is unique and as such, all manufacturers follow a nearly identical retrofitting concept to enhance the standard shelving structures in longitudinal and lateral strength.

5.1 Library Shelving Installation

As compared with a typical Midwestern state where a manufacturer's standard shelving unit is assembled, ganged into a range and perhaps levelled in place but left truly free-standing with wall shelving only anchored into drywall at the top, a California library shelving installation is much more demanding:

- A floor-anchored installation requires additional use of shims to produce a level and plumb shelving range installation.
- Because shelving is required to be anchored in place, it is considered to be part of the building structure, which results in the requirement that the shelving installation contractor be licensed to perform this specialty work. Installation of shelving in California requires a minimum C-61 Specialty Contractors License on the part of the organization doing the work. (See **State of California, Rules and Regulations of the Contractors State License Board.**)

5.1.1 Professional Review

Shelving installations in new construction fall under the responsibility of the architect, and are pursuant to all applicable Federal, State and local codes, plus, any local governing control responsibility, such as Fire Department review.

A complete set of documents consisting of floor plan layout and product engineering drawings, including structural calculations carrying the stamp of a licensed structural engineer are required. A less-extensive installation may require only written documents from the vendor/installer verifying that the installation meets commonly accepted standards.

For additional reference, The Division of the State Architect, State of California (www.dsa.ca.gov) has published the following: Manual of Recommended Practice, Seismic Safety Standards for Library Shelving by John A. Shelton, Supervising Structural Engineer. Sacramento: California, California State Library Foundation, c1990.

5.1.2 Seismic Installation Compliance

Seismic installation compliance must comply with the Uniform Building Code (UBC), Chapter 23, and is based on Table No. 23-B, Category No. 10. Here, steel shelving falls under the definition of being a Storage Rack. When referring to Table No. 23-P, II. Non-structural Components, line 7, *Bookstacks* are specifically called out. The attachment of shelving, described as *equipment supported by a structure* is prescribed in UBC Section 2312 (g). Additional current code requirements may be found in the California Building Code (California Code of Regulations, Title 24, Part 2).

5.2 Shelving Types

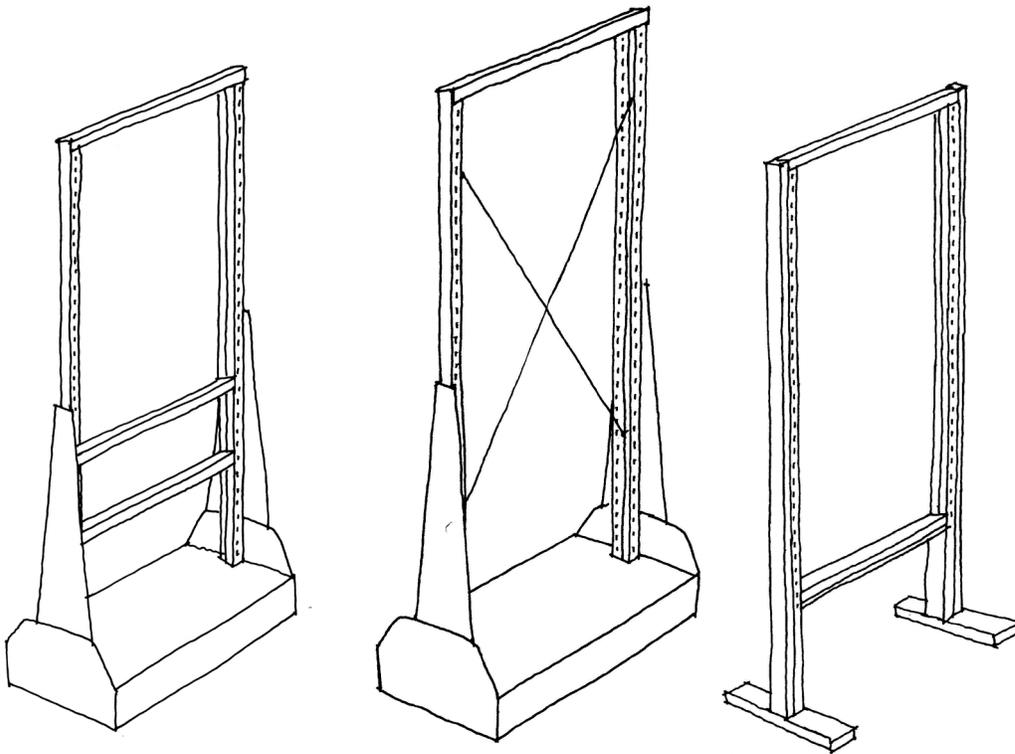


Illustration XIII: Closed Base Welded Seismic-braced frame (L) and Welded Sway-braced frame (C) and “T”-based frame (R)

Type	Description	Seismic Rating	Aesthetic Rating
Cantilever-style Shelving	The most widely used steel shelving system in the State of California is cantilevered welded-frame construction.	++	+
Closed Base	With the use of closed base shelving, all attachment hardware and anchors are concealed below the base shelf.	++	++
Open Base	With the use of open base shelving, as described below, T-base, or European-style shelving, the reality is that the required attachment metal brackets and floor anchoring hardware are visible below the shelving.	++	--
Starter-Adder Shelving	In the State of California, the requirement for special seismic reinforcement of steel Cantilever-style shelving eliminates the use of starter-adder construction in a cantilever-style product.	NA	NA
T-base, or European-style Shelving	The structural demands for reinforcing the current T-base or European-style shelving requires the manufacturers to factory-alter the product with welded-in brace elements at the base, and may require a specially fabricated vertical support column.	-	-

6. ACQUISITION OF LIBRARY SHELVING

6.1 The Marketplace

The marketing practices of shelving manufacturers may have some effect on how shelving is selected or specified for a library. Manufacturers of wood shelving, or wood-and-steel-combination shelving, are predominantly library furniture manufacturers, and distribute their products through furniture vendors.

Distribution of cantilever-style steel shelving may or may not be through a furniture vendor. The demands for quality installation performance is evident in all categories, but reaches critical importance when confronting the assembly and installation of cantilever-style steel shelving in the State of California. Cantilever-style steel shelving manufacturers will typically appoint a single distribution vendor for their product in any given market area. That distributor is responsible for bringing the value-added elements of local sales support, customer service, product service, provision of engineering documents, and finally, the skilled labor familiar with the product being used. Local representation for a shelving manufacturer can be located by calling the manufacturer directly, usually at their toll free number.

6.2 Product Uniformity

Considering the limitations on the number of shelving products applicable for use in the State of California, and, in an analysis of each individual construction feature, one will find great uniformity in specification. When installed to meet the mandates of California seismic requirements, there is little difference among shelving products fabricated by different manufacturers.

6.3 Specifications and Bidding

The prime purpose for following a bid procedure when procuring shelving is to be able to make the purchase at the lowest possible cost. In that context, this procedure has merit for most initial purchases. A separate document, *Furniture and Shelving: Specification and Bidding*, available on the Libris Design website details the various options for a bid process, sole source and proprietary specifications, detailed specification writing, and specific bid conditions and requirements.

The vendor will be required to submit a shelving layout plan, which is similar to a furniture plan. This submittal must include a seismic calculation report and a stamped original signed by the structural engineer who performed the calculations. The cost of this engineering study is typically included in the shelving bid. The vendor will also provide shop drawings showing the installation details as well as any details required for lighting installation or custom end panels or canopy tops

if included in the shelving package. In addition to the stamped installation plans and the shop drawings, the shelving vendor will submit a shelving *schedule*, which will outline the quantity and location for each specific shelving type, included in the contract.

At this time, it will be wise for the librarian to “check it twice.” With plans, shelving schedule, building program, and calculator in hand, the librarian should count the shelving units on the plan. This can often be the last chance to avoid a serious mistake.

7. PAINT FINISHING AND REFINISHING

7.1 New Paint Finish

Finishes on metal shelving have been under the pressure of market competition and are regulated by EPA rules and regulations. As a result, virtually all major shelving manufacturers now use a state-of-the-art, powder-coat paint finish process. While the powder-coat paint finish is much more durable than the former wet paint finish processes used, it is not as easy to change colors or achieve custom color choices without experiencing a costly set-up and processing charge for such requirements.

7.2 Re-Finishing Used Shelving for Re-Use

In the State of California, it would be unlikely to find a legitimate wet paint source for re-painting used shelving. The fact is that state-of-the-art, powder-coat painting is available, and its many benefits also apply to the re-painting process.

It is well to keep in mind that re-painting companies are strictly that, and, as such, they can not be expected to do any clean-up or preparation work on the parts presented to them for the new paint finish. For an extra cost, the only prep work they can provide is to pass the shelving parts through their high heat ovens to purge the parts of wax and oils. Further cleaning of parts to remove gum, scotch tape, artist paints, etc. remains the owner’s responsibility. Be wary of any proposal to electrostatically paint any shelving in place.

Re-use of existing shelving is a process followed presumably to contribute economically to the cost of a project. This concept needs careful evaluation and the following costs in terms of time and labor must be considered:

- Removal and storage of materials
- Dismantling and disassembly of each shelving component
- Disconnecting any electrical stack light components
- Containerizing and transportation to paint shop
- Re-painting contract
- Re-handling and re-delivery of shelving to library facility
- Re-distribution within the building; re-installation to code

It would not be unusual for the cost of this entire process to total 75% of the cost of new shelving and if compared with a large, competitively bid new installation, any cost savings would be unlikely. While refurbishment and re-use of existing shelving is functionally possible, it is crucial to factor in the cost benefit and convenience of being able to leave materials on existing shelves until the time for a direct transfer to new shelving.

8. SHELVING INSTALLATION

Closed base shelving in a new installation should be installed over the fully carpeted floor. To have carpeting installed around already-installed shelving will greatly increase the carpet installation cost, and will achieve no significant cost savings on the carpet. There is no cost difference in either option (over carpet or over floor), although installing over carpet places a heavy responsibility on the shelving contractor to avoid soiling or damaging the carpet during the installation process. For open base shelving installations, the installation will always be done over finished, carpeted floors.

Typically the installer will lay out the entire installation using chalk marks or strings to outline the locations of stack units and aisles. The vertical frames are uncrated and positioned in their future locations. Since freestanding units over 60" high will require bolting to the slab to meet the seismic zone requirements, most installers will "burn" or "melt" a small patch of the carpet for each bolt before they begin drilling to avoid pulling zippers and damaging the carpet material.

It will be important for the librarian or project manager to instruct the shelving installers on any specific shelf spacing requirements or adjustments to the number of shelves to be installed in each unit. Specifying which units will have six shelves and which will have seven shelves will save countless time making these adjustments later. The installer will have a complete set of shop drawings with the location and shelving type for the entire job, but any special requests or changes to this should be made before the installation begins.

The Owner's final responsibility will be to perform a punch list, or thorough inspection of the shelving installation. Usually minor nicks or dings to the paint can be touched up on site, and the shelving vendor should leave behind some of this touch up paint for future nicks and dings. Occasionally however, units will be poorly manufactured, painted, or damaged in transit. These defective units must be rejected and a specific deadline for replacement must be agreed upon. A small percentage of final payment may be withheld until this has been accomplished.

9. SHELVING RELOCATION

Relocation of shelving is a complicated task in California because all shelving must be anchored in place. As a result, any relocation becomes a significant task. Because a properly installed shelving installation is considered part of the permanent building structure, a specialty contractor must be hired to do the work. (See Section 5.1 above.) Relocating shelving within an existing

facility may provide an unexpected and expensive surprise if the building at some point has been re-carpeted and now after the shelving has been moved, well-preserved strips of the original unfaded carpet appear where the old shelving once stood. If re-carpeting the area had not been part of the scope of work, it may now become a necessity.

Relocation of shelving in long ranges as assembled is not possible. If relocated within the same large area, the ranges may be broken down into manageable groupings for reassembly in new locations. Parts should be carefully labelled and stored. Other than this, relocation must be interpreted as disassembly, moving and reassembly.

10. GLOSSARY OF SHELVING TERMS

Actual Dimensions	The true physical dimension of a measurement. An actual 9” shelf is 9” deep.
Architectural Void	An open area, which is created when two shelving units meet in a corner at a right angle, or a double-faced unit meets a single faced wall unit at a right angle.
Back Panel - Metal	Back panels are an option except for plastic laminate casework-type shelving where they are integral to the structure. Backs may be single-faced, finished on one side only, or they may be double-faced, finished on both sides, if a common back is used between shelving faces.
Book Shelving	A modular shelving storage system with rigid vertical supports that support a flat shelf on underside clips or pegs or by brackets affixed to shelf ends engaging a post in cantilevered fashion.
Bookstacks	A library facility term describing a large grouping of shelving sections within a prescribed building space; typically steel cantilever-style construction.
Book Supports	Books supports are used to hold book volumes upright and uniformly packed on a shelf.
Canopy Top	Other than case-style shelving where this is integral to the structure, canopy tops are considered to be an accessory typically required for sections under 72” in height but available for units of all heights.
Cantilever-style Steel Shelving	Any type of shelving which uses a heavy-duty, slotted, vertical support column, supported by an appropriate load-bearing base structure from which outrigger type shelves can be bracket-attached to form single-faced or double-faced shelving units.
Capacity	The number of volumes per linear foot or per shelving units based on collection type.
Casework	Also known as case goods. Counters or cabinets of custom design and construction, which are usually fixed to the structure and are included in the general construction contract.

Case-Style Shelving	Any type of shelving system that uses a full panel, vertical component from floor to top with adjustable shelves or supports which engages at ends into these vertical panels. This style of shelving will always have a closed base shelf assembly, and a canopy top.
Closed Base Shelving	The closed base structure used on cantilever-style shelving is designed to produce load bearing support and lateral stability. The closed base shelf is used to fit between lateral bracing base members and provides a base storage shelf, plus, a closed toe kick along the aisle face.
Compact Shelving	(Also referred to as High Density, Moveable Aisle or MAC shelving.) These are shelving systems that ride on moveable carriages over floor-installed rails. The benefit is to maximize use of floor space by having one (1) access aisle, which is located by moving the carriage mounted shelving in a manner that opens an access aisle at a desired location.
Divider-type Shelving	Divider-type shelving is an optional accessory shelf, which comes with a number of adjustable vertical support members that fit into slots in the surface of the shelf.
Double-faced Shelving	A free standing shelving unit that is accessible from two aisle faces, with materials fronting on both faces. (See Illustration IV.)
End Panel	A decorative end to cover the exposed structure of Cantilever-style steel shelving ranges, or an integral part of the shelving structure on case-style shelving.
Fillers	Fillers are a manufactured shelving product used to close or obscure an architectural void that is created by either the architectural design or the stack layout.
Growth	Growth is a dimensional concept used in applying actual shelving size dimensions to actual plan layout and physical building spaces. Growth is the factoring in of actual shelving depths that are greater than published nominal dimensions, plus, the growth in length of assembled ranges due to the insertion of reinforcing gussets between frames, as their thickness increases the length.
K-D Frame Construction	Knocked-down or Starter-Adder construction is a type of fabrication which requires the Cantilever-style shelving vertical support columns be constructed so that one or more cross members must be field-connected into place between the columns as the columns are ganged into an assembly.
Millwork	See Casework.
Multi-tier Stack	Specially-engineered and constructed steel shelving systems which are assembled as two or more tiers of shelving sections in which the upper level support members are integral to the stack system and separate from any building structural elements.

Nominal Dimensions	The amount of shelving space available calculated by adding the physical depth of the metal shelf and adding in the void created behind the shelf.
Open Base Shelving	Also referred to as T-base shelving, or European-style shelving. The vertical support column is welded to a cross member at the bottom, forming an inverted T which produces load-bearing support and lateral stability.
Periodical Display Shelving	Periodical display shelving provides a display surface for current periodicals with back issue storage below. The display shelves are sloped and are either fixed in position, or hinged to side brackets allowing them to be lifted for better access to the back issue storage shelf.
Range	See Shelving Range.
Range Aisle	Aisles that run parallel to the stack aisles, which are intended to break up the side aisles into increments, are known as range aisles. These are required to be 36" wide to meet accessibility requirements.
Reference Shelves	Retractable reference shelves are available as an accessory option from manufacturers of metal shelving.
Shelving Section	A term used to describe one complete set of modular component parts, which assemble to become a single-faced or double-faced shelving assembly consisting of required base, structural supports and adjustable shelves.
Shelving Range	A term used to describe an assembled group of shelving sections to produce descriptive visual images such as: a single-faced range; a double-faced range of counter height sections; or, a six-section, double-faced range.
Single-faced Shelving	A shelving unit that is accessible from one aisle face, with materials only fronting on that face. Predominately, this will be wall-mounted shelving, with or without back panels.
Starter-Adder Shelving	See K-D (knocked-down) Frame Construction.
Storage Shelving	Generally rugged and industrial in nature, with open frame or panel enclosed structural vertical posts having some means of mechanically fastening shelf supports for flat storage shelves. Shelves may be bolted in place, or, supported on clips, or on rails that hook into posts to allow some degree of adjustability in spacing. If adjustable, commonly 1-¼" - 2" increments only are used.
Top Tie Strut	Horizontal overhead beams that connect a bank of stack ranges.
Welded-frame Construction	Defines a type of factory-fabrication chosen by most manufacturers in which the cantilever-style shelving vertical support columns are jig-built with a minimum of one top and one bottom cross member welded between the vertical columns, resulting in a four-sided space frame that establishes the shelving module width in assembly.

11. SOURCES OF FURTHER INFORMATION

Architectural Woodworking Institute (www.awinet.org)

Woodworking Institute of California (www.wichet.org)

The Division of the State Architect, State of California (www.dsa.ca.gov)

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