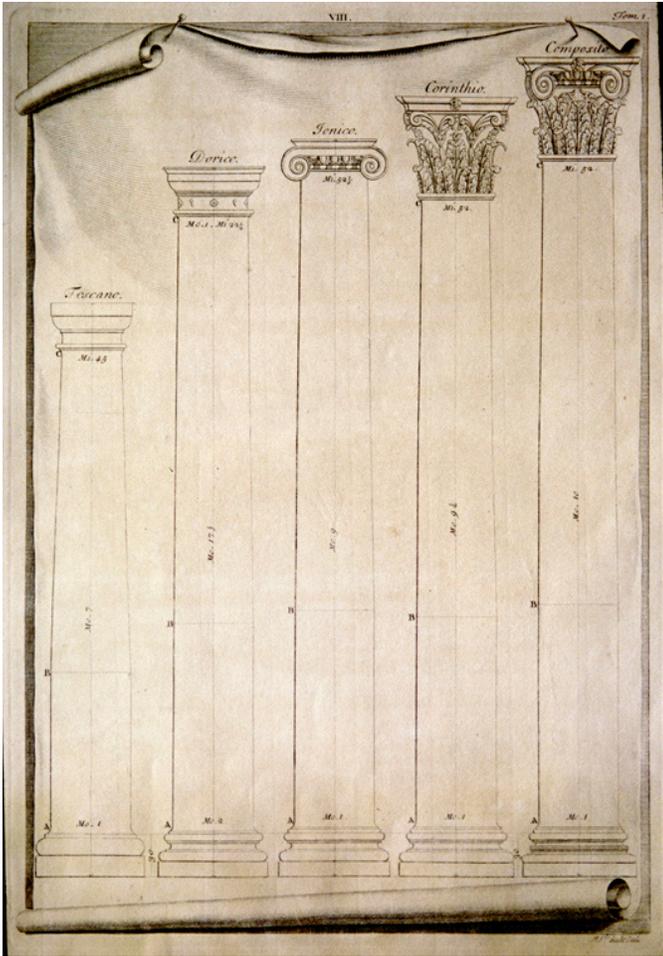


Classical Architectural Vocabulary



The Architecture of A. Palladio in Four Books, Leoni (London) 1742, Book 1, plate 8.

The five classical orders

The five orders pictured to the left follow a specific architectural hierarchy. The ascending orders, pictured left to right, are: Tuscan, Doric, Ionic, Corinthian, and Composite.

The Greeks only used the Doric, Ionic, and Corinthian; the Romans added the 'bookend' orders of the Tuscan and Composite. In classical architecture the selected architectural order for a building defined not only the columns but also the overall proportions of a building in regards to height. Although most temples used only one order, it was not uncommon in Roman architecture to mix orders on a building. For example, the Colosseum has three stacked orders: Doric on the ground, Ionic on the second level and Corinthian on the upper level.

column

In classical architecture, a cylindrical support consisting of a base (except in Greek Doric), shaft, and capital. It is a post, pillar or strut that supports a load along its longitudinal axis.



Doric order

The oldest and simplest of the five classical orders, developed in Greece in the 7th century B.C. and later imitated by the Romans. The Roman Doric is characterized by sturdy proportions, a simple cushion capital, a frieze of triglyphs and metopes, and mutules in the cornice.



Ionic order

The classical order originated by the Ionian Greeks, characterized by its capital with large volutes (scrolls), a fascinated entablature, continuous frieze, usually dentils in the cornice, and by its elegant detailing. It is less heavy than the Doric but less elaborate than the Corinthian.



Corinthian order

The slenderest and most ornate of the three Greek orders, characterized by a bell-shaped capital with volutes and two rows of acanthus leaves, and with an elaborate cornice.

Classical Architectural Vocabulary

Doric order

entablature

In classical architecture, the elaborated beam member carried by the columns, horizontally divided into architrave, frieze, and cornice. The proportions and detailing are different for each order, and strictly prescribed; a similar feature as the crown of a wall.

cornice

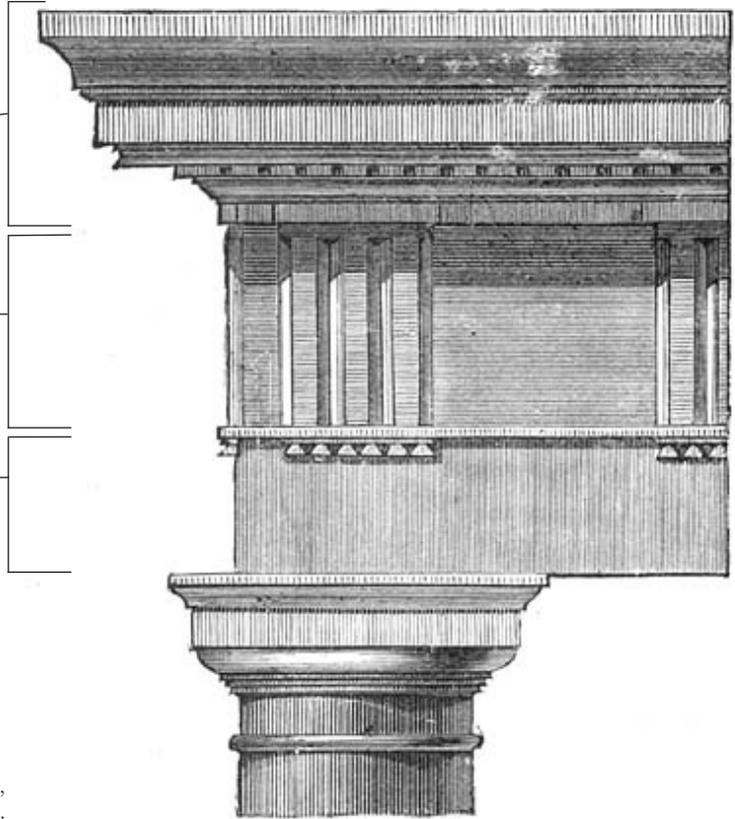
Any molded projection which crowns or finished the part to which it is fixed

frieze

The middle horizontal member of a classical entablature; this can be plain or adorned with dentils, metopes and triglyphs, or organic and sculptural motifs.

architrave

The lowest member of an entablature that represents the beam that spanned from column to column in ancient architecture, resting directly on the capitals. This element can be plain, as it is in the Doric, or banded as seen in the Ionic and Corinthian. The architrave can also refer to the ornamental moldings around the faces of the jambs (sides) and lintels (top beams) of a doorway or other opening.



From Leoni, *The Architecture of A. Palladio in Four Books*. London, 1742, Book 1, plate 15, Doric order, base and pedestal.



triglyph

An ornament in a Doric frieze consisting of raised blocks of three vertical bands separated by V-shaped grooves. In ancient architecture the triglyph had a structural function: this element was actually the end of ceiling beam that projected through the facade slightly to rest on the lintel beam supported by the columns. Although the structural system changed the element was retained as a decorative feature.



metope

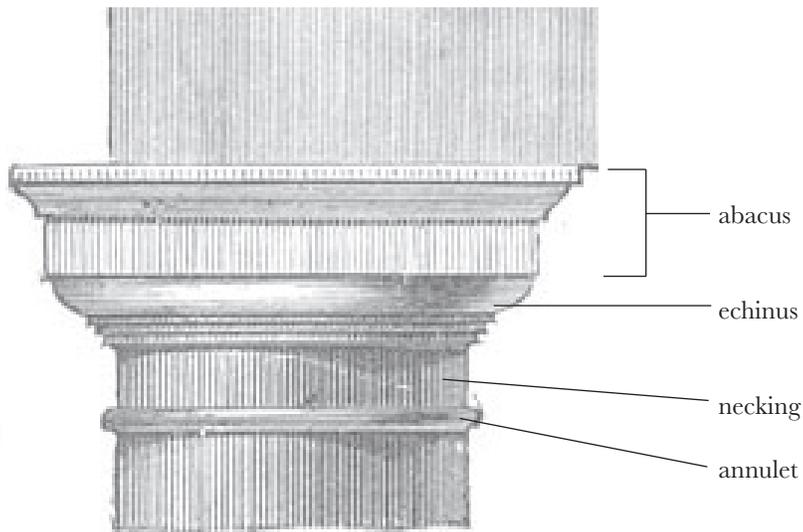
The panel between triglyphs in the Doric frieze; they may be plane or embellished with a decorative image such as a rosette or bucrane.



mutule

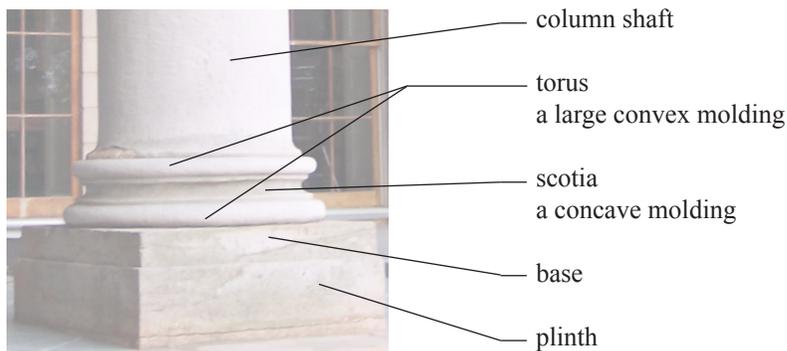
A projecting flat block under the Doric cornice; it is the Doric equivalent of a modillion in the Ionic order. This is usually decorated with rows of six guttae each.

Advanced Classical Architectural Vocabulary



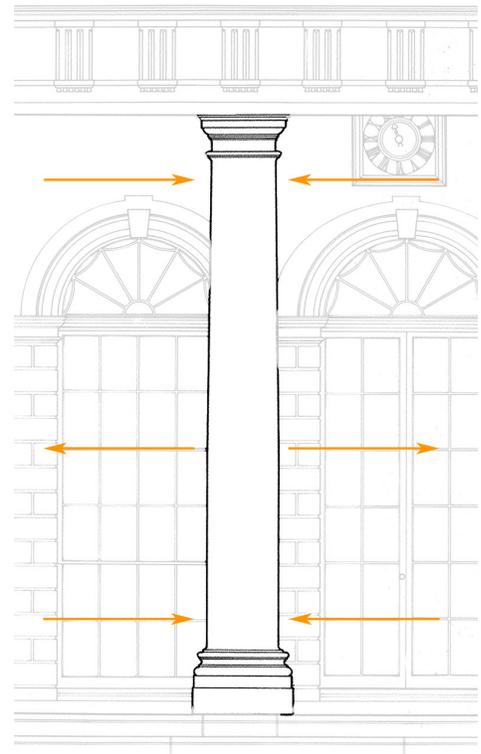
capital

The topmost member, usually decorated, of a column, pilaster, etc. Looking at the capital is the easiest way to discern the order of the column. The diagram above depicts the specific elements of a Doric capital, the order used on the east and west porticos.



base

Lower part of a column or pier, wider than the shaft, and resting on a plinth, pedestal, podium, or stylobate. The bases of the Doric columns of the East and West facades sit on plinths and are considered **attic bases**. It was relatively uncommon in the ancient world for Doric columns to have an attic base given the elevated architectural language of the upper and lower torus; Doric bases were typically much simpler.



entasis

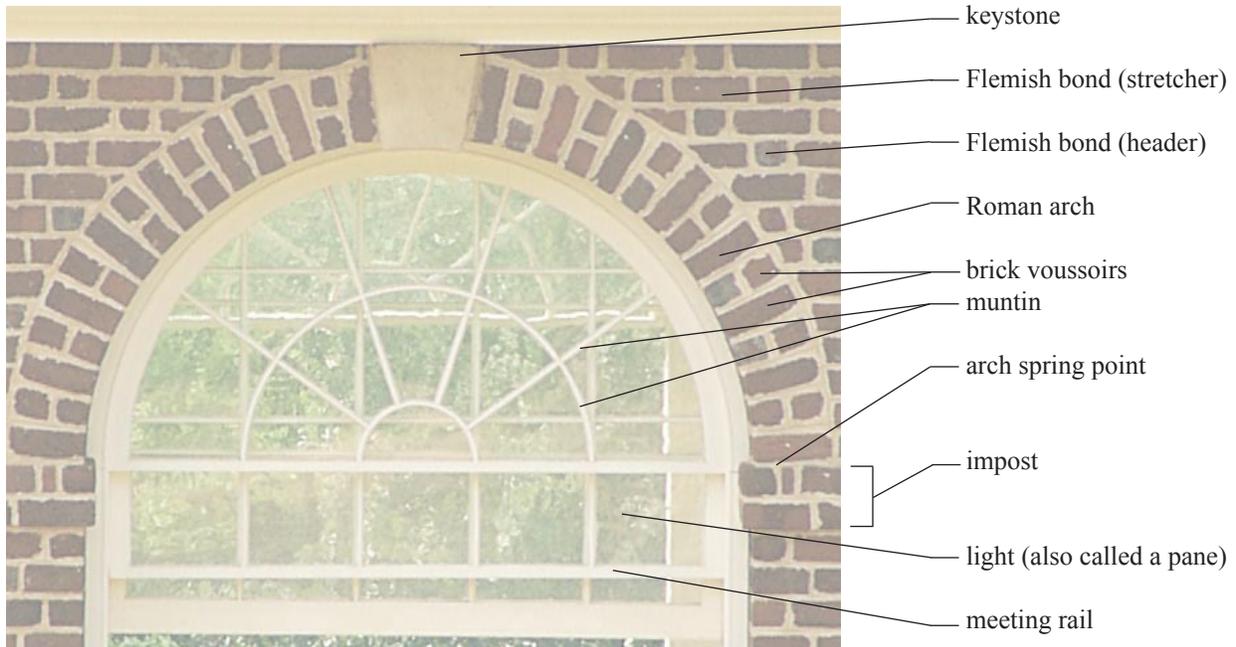
A slight convexity given to the shaft of a column to correct an optical illusion of concavity if the sides were straight (see diagram to right).



intercolumniation

The clear space between two adjacent columns, usually measured at the lower parts of the shafts

Advanced Classical Architectural Vocabulary



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Illustrated Architecture Dictionary

Arch



A curved or pointed structural member which is supported at the sides or ends

Arches vary in shape from the horizontal flat arch to acutely pointed arches

An arch sometimes consists of wedge-shaped blocks called [voussoirs](#)

Types of arches:

[Baskethandle](#) (elliptical) arches are found in [Italianate](#), [Beaux Arts Classical](#) styles

A [compound arch](#) is an arch formed by concentric arches set within one another

Flat arch/jack arch: a flat arch (as a [lintel](#) with a [keystone](#)); an arch of the thickness of one brick; an arch whose intrados is flat or almost flat, instead of being curved or rounded.

Jack arch lintel: A door or window lintel constructed with splayed bricks.

Florentine arches have [voussoirs](#) longer at the crown than at the springing (the point where an arch rises from its supports)

[Ogee/Venetian arch](#) is a molding formed by two curves, the upper concave and the lower convex, so forming an S-shaped curve

[Horseshoe arch](#)

[Pointed \(Gothic\) arches](#) are found in [Gothic Revival](#) style

Round arches are found especially in [Italianate](#), [Italian Renaissance Revival](#), [Richardsonian Romanesque](#) styles

A **segmental arch** is a circular arch in which the inner circle ("intrados") is less than a semicircle

Syrian arches are found in [Richardsonian Romanesque](#), [Shingle](#), styles

Splayed arch: An arch opening which has a larger radius in front than at the back

Transverse arch: An arch of the vault that runs perpendicular to the nave that divides one bay - or groin vaults - from another.

Tudor arches (flattened Gothic) arches are found in [Tudor Revival](#), [Gothic Revival](#) styles

Tympanum: The recessed face of a pediment

See also: [Coliseum - Roman Arches](#)

Excerpts from
Gardner's Art Through the Ages, Tenth Edition
By Richard G. Tansey and Fred S. Kleiner
Harcourt Brace College. Pub. 1996, p. 325.

Horseshoe Shaped Arches

The lower arches [in the Mosque of Cordoba] are horseshoe shaped ... now closely associated with Muslim architecture. Visually, these arches seem to billow out like sails blown by the wind, and they contribute greatly to the light and airy effect of the mosque's interior.

Early Islamic buildings had wooden roofs, and the experiments with arch forms were motivated less by structural necessity than by a desire to create rich and varied visual effects...

Here, the large ribs that subdivide the hemispheric surface of the dome into a number of smaller sections are primarily ornamental.

In the hands of [Gothic](#) builders, centuries later, ribs in combination with the pointed arch became fundamental structural elements of a new and revolutionary architectural system.

Examples from Buffalo architecture:

- *Illustration above*: [Clement House](#) (Tudor Revival)
- [Forest Lawn Cemetery Main Street Entrance Gate](#) (Romanesque Revival)

- [St. Anthony's RC Church](#) (Romanesque Revival)
- [St. Paul's Episcopal Cathedral](#) (Gothic Revival)
- [Campanile Apartment Building](#) (Romanesque Revival)
- [Blessed Trinity RC Church](#) (Transverse arches)
- [Lipke House](#) (Flat arch/jack arch)

Other examples:

- [Temple of Diana, Nimes, France](#) (Roman arch)

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| [Home Page](#) |

[Buffalo Architecture Index](#) |

[Buffalo History Index](#) |

[E-Mail](#) |

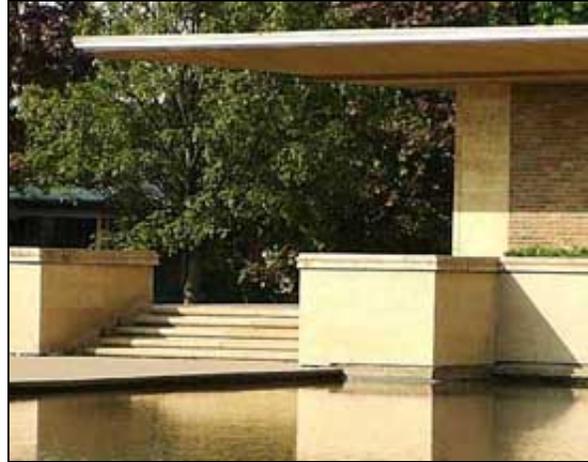


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Cantilever



1. A projecting bracket used for carrying the cornice or extended [eaves](#) of a building
2. A beam, girder, truss, or other structural member which projects beyond its supporting wall or column
3. A beam anchored at only one end

Jetty: A cantilever in a traditionally timber framed building

Cantilever VS [post-and-lintel system](#)

Examples from Buffalo architecture:

- *Illustration above:* [Kleinhans Music Hall](#)
- [Graycliff](#)
- [Jekel House](#)
- [Martin House](#)

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Capital



Architecture

The head or crowning feature of a [column](#) or [pilaster](#)

Body Language

The Greeks were first to declare that architecture was based on the proportions and form of the human body. "Capital," for example, comes from the word "caput," or head.

In addition, dimensions were measured in terms of a human unit like the foot (*piede* in Italian).

[Dentil molding](#) is the exact shape of a toothy dental smile on a jack-o'-lantern.

And need we explain the folds of a [groin vault](#)?

- *The Annotated Arch*, by Carol Strickland. Kansas City: Andrews McMeel Pub., 2001, p. 32

Many features that we associate with ancient columns are artistic interpretations of earlier plant and wooden structural elements. See Frank E. Wallis, [Greek Architecture and American Buildings](#), 1910 book excerpt.

Cushion, block, or cubic capital: A very simple cube-like capital with bottom corners tapered. The block capital is particularly characteristic of Ottonian and Romanesque Germany and England.

Found in classical Greek and Roman architecture and derivatives, including [Beaux Arts Classicism](#), [Classical Revival](#), [Federal](#), [Georgian Revival](#), [Greek Revival](#), [Neoclassicism](#), [Renaissance Revival](#), [Second Empire](#)

Furniture

The column and capital have been used as decoration and for functional supports on many styles of furniture.

Examples from Buffalo architecture:

- *Illustration above* - Ionic capital: [135 Linwood Avenue](#)
- **Doric** capital:
 - [Knox House](#)
 - [Buffalo and Erie County Historical Society Museum](#)
 - [Forest Lawn Administration Building](#)
- **Ionic** capital:
 - [Albright-Knox Art Gallery](#)
 - [Albert F. Laub Mausoleum](#)
- **Corinthian** capital:
 - [Williams-Butler House](#)
 - [Buffalo Savings Bank](#)
 - [James McNulty Monument](#)
 - [Edward Gaskin House, 41 Chapin Pkwy](#)
 - [The Mansion on Delaware Avenue](#)
 - [Wilcox Mansion / TR Inaugural Site](#)
- **Tuscan** capital:
 - [Lackawanna Public Library](#)
 - [Charles W. Goodyear House](#)

- [George K. Birge House](#)
- [Frank H. Goodyear Mausoleum](#)
- **[Composite capital:](#)**
 - [Miller House](#)
 - [Williams-Pratt House](#)
 - [Kensington Building, 3060 Bailey Ave.](#)
- **[Cushion capital:](#)**
 - [St. Francis RC Church](#)
 - [St. Mary of Sorrows/King Urban Life](#)
 - [Maytham House](#)
 - [H. H. Little House](#)
- **Eclectic capital:**
 - [Holy Angels RC Church](#)
- **Queen Anne style capital:**
 - [Old Editions Book Shop and Café](#)
 -
- **Arts & Crafts capital:**
 - [Palmer House](#)
- **Eastlake cast iron:**
 - [The Granite Works, 844 Main Street](#)
- **Commercial Richardsonian Romanesque cast iron:**
 - [Webb Building](#)

Other examples:

- Egyptian palm capital - [British Museum, London, England](#)
- [St. Bartholomew's Episcopal Church, New York City](#) 5 examples of Romanesque Revival capitals
- [Pedlar People Sheetmetal Building Material Catalog: Capitals, Canada](#)
- *Furniture:* [Sheraton worktable](#)

- [Catalonian National Art Museum, Barcelona, Spain](#) Romanesque capitals
 - Mudéjar capitals: [Synagogue of Santa Maria La Blanca, Toledo, Spain](#)
 - Islamic stalactite capital - [Sultan Ahmet Mosque / Blue Mosque](#)
-

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| [Home Page](#)

| [Buffalo Architecture Index](#)

| [Buffalo History Index](#)

| [E-Mail](#) |

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Churches - Glossary

<p>Click on photos for larger size</p>	<p>All examples are from churches in Buffalo, New York</p>
	<p>Apse The recess, usually semicircular, at the end of a Roman basilica or a Christian church. Illustration from St. Louis RC Church</p>
	<p>Arcade A series of arches supported on piers or columns. Illustration from St. Louis RC</p> <p style="text-align: center;">Blind Arcade: An arcade applied to a wall surface, with no actual openings, to serve as a decoration.</p>
	<p>Baldachino / baldachin / baldacchino / baldaquin An ornamental canopy over an altar, usually supported by columns, or a similar form over a tomb or throne</p>
	<p>Basilica In Roman architecture, a public building for assemblies, especially tribunals, rectangular in plan, entered on a long side. In Christian architecture, an early church somewhat resembling the Roman basilica; usually entered from one end with an apse at the other creating an axial plan.</p>
	<p>Bay A compartment that serve as a unit of division in a building. in a Gothic cathedral the transverse arches and adjacent piers of the arcade divide the building into bays, the design of which is an architectural unit repeated in each bay.</p> <p>Illustration from St. Louis' RC</p>
	<p>Buttress (BUT ris) A structure, usually brick or stone, built against a wall for support or reinforcement.</p>



Pier Buttress: an exterior pier counteracting the thrust of a vault or arch.

Flying Buttress: masonry support consisting usually of a pier or buttress standing apart from the main structure and connected to it by an arch.

Illustration from [Asbury Delaware Ave.](#)



Capital

The top part of a pillar or column

Illustration from [St. Francis Xavier RC](#)



Cell

One of the compartments of a groin or rib **vault**, in the Romanesque period usually of plastered rubble, in the Gothic period of neatly coursed stones

Illustration from [St. John's Grace Episcopal](#)



Chancel (CHAN sul)

The space around the altar of a church for the clergy and sometimes the choir, often enclosed by a lattice or a railing.

Illustration from [Central Presbyterian](#)

Chapel

"A chapel is a holy place or area of worship for Christians, which may be attached to an institution such as a large church, a college, a hospital, a palace, a prison or a cemetery, or may be free-standing and unattached to another building." - [Wikipedia: Chapel](#)



Clerestory Also "clearstory." (CLEAR story)

The upper part of the **nave**, **transepts**, and choir of a church, containing windows

Illustration from [St. Louis' RC](#)



Crocket

A decorative feature carved in various leaf shapes and projecting at regular intervals from the angles of spires, pinnacles, canopies, gables, etc., in Gothic architecture.

Illustration from [St. Louis' RC](#)

Crossing

The space at the interior intersection of the **nave**, **chancel**, and **transept** of a church; often surmounted by a crossing tower or **dome**.

	<p>Cruciform Shaped like a cross. This is basic design for many Christian churches.</p>
	<p><u>Dome</u> A vault of even curvature erected on a circular base. The section can be segmental, semicircular, pointed, or bulbous.</p>
	<p><u>Foil</u> A lobe or leaf-shaped curve formed by the cusping of a circle or an arch. The number of foils involved is indicated by a prefix, e.g. trefoil, quatrefoil, multifoil Illustration from Asbury Delaware Ave.</p>
	<p>Fresco The art of painting on fresh, moist plaster with pigments dissolved in water.</p>
	<p><u>Gothic Revival</u></p>
	<p><u>Icon</u> Illustration from St. Louis RC</p>
	<p><u>Lancet Window</u> A slender pointed-arched window. Illustration from St. John's Grace Episcopal</p>
	<p><u>Mosaic</u> A picture or decorative design made by setting small colored pieces, as of stone or tile, into a surface.</p>
	<p>Narthex Greek for "enclosure" The narthex is an entryway or gathering room leading into a church. The area is sometimes referred to as "vestibule" or "foyer." In the narthex people often gather before and after a service to greet each other It is an area for bridging the "sacred" and the "secular."</p> <ul style="list-style-type: none"> • St. Andrew's Episcopal Church • Calvary Episcopal Church, Williamsville, NY



[Nave](#)

From navis, ship, an early symbol of the church.
The central aisle; the part of a church located between the chief entrance and the **chancel**, and separated from the aisles by piers or columns.
Illustration from [St. Ann's RC](#)



[Pinnacle](#)

A small turret-like termination crowning spires, **buttresses**, the angles of parapets, etc.; usually of steep pyramidal or conical shape and ornamented, e.g., with **crockets**.
Illustration from [St. Ann's RC](#)



[Reredos](#)

An ornamental screen or wall at the back of an altar
Illustration from [St. Ann's RC Church](#)



[Rib](#)

One of the curved pieces of an arch
Illustration from [St. Ann's RChurch](#)

[Romanesque Revival](#)

Style of architecture, popular in U.S. 1870-1900, distinguished by round arches.



[Rose Window](#) Also: [Wheel Window](#)

The round window with **tracery** frequently found on the facades of Gothic churches.
Illustration from [St. Louis RC Church](#)



[Sanctuary](#) (SANGK choo air ee)

1- The holiest part of a sacred place, as in a Christian church around the altar.
2- A sacred place, such as a church, temple or mosque.
Illustration from [St. Ann's RC](#)



[Side aisle](#)

Aisle(s) to the side of the **nave** (central aisle)
Illustration from [St. Louis RC](#)

[Tracery](#)

The ornamental intersecting work in the upper part of a window, screen, or panel, or used decoratively in blank arches and **vaults**.
Illustration from [St. John's Grace Episcopal](#)



Transept (TRAN sept)

The crosswise part of a **cruciform** church, crossing the **nave** at right angles.

Illustration from [St. Louis RC](#)



Vault

An arched structure of stone, brick, or reinforced concrete, forming a supporting structure of a ceiling or roof

Barrel vault:/Barrel roof: A vault having a semicylindrical roof

Groin(ed) vault/Cross vault: A compound vault in which barrel vaults intersect

Rib(bed) vault: A vault supported by or decorated with arched diagonal ribs (rib: one of the curved pieces of an arch)

Illustration from [St. Ann's RC](#)

Vestibule

(VES ti byool)

A small entrance hall or passage between the outer door and the interior of a house or building

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Column



Architecture

A supporting pillar consisting of a base, a cylindrical shaft, and a [capital](#)

Latin: "columna" - a post

Column vs. post: post lacks the essential qualities of a column: base, shaft and capital

Columns are found in virtually all styles of architecture.

Many features that we associate with ancient columns are artistic interpretations of earlier plant and wooden structural elements. See Frank E. Wallis, [Greek Architecture and American Buildings](#), 1910 book excerpt

In cemeteries, a broken column represents life cut off.

Shapes:

- round
- [engaged](#)
- flat ([pilasters](#))
- banded
- paneled pilaster

Materials:

- wood
- granite
- limestone
- marble
- brick covered with stucco or or plaster
- cast iron
- [sheet metal](#)
- pressed tin capitals
- fiberglass
- cast aluminum

Shafts: The shaft, which rests upon the base, is a long, narrow, vertical cylinder that in some orders is articulated with fluting (vertical grooves).

- [fluted](#) (Greek)
- round (Roman),
- [reeded](#) (e.g., [Art Deco](#))
- square (often paneled)
- [banded](#) (Roman)
- [twisted](#) ([Baroque](#))

Styles of Classical columns:

- [Doric](#) (although Doric columns have no base)
- [Ionic](#)
- [Corinthian](#)
- [Composite](#)
- [Tuscan](#)

Queen Anne column: sometimes used instead of a Classical column on Queen Anne style porticos. [Example](#)

[Colonnade:](#) A series of columns in a straight line carrying an entablature

[Arcade:](#) A series of arches supported by pillars, piers or columns; a roofed passageway or lane, especially one with shops on either side

Classical two-story columns are found in [Beaux Arts Classical](#), [Greek Revival](#), [Neoclassical](#) styles

Classical one-story columns are found in [Italianate](#), [Beaux Arts Classical](#), [Greek Revival](#), [Neoclassical](#) [Colonial Revival](#), [Queen Anne](#), [Italian Renaissance Revival](#) styles

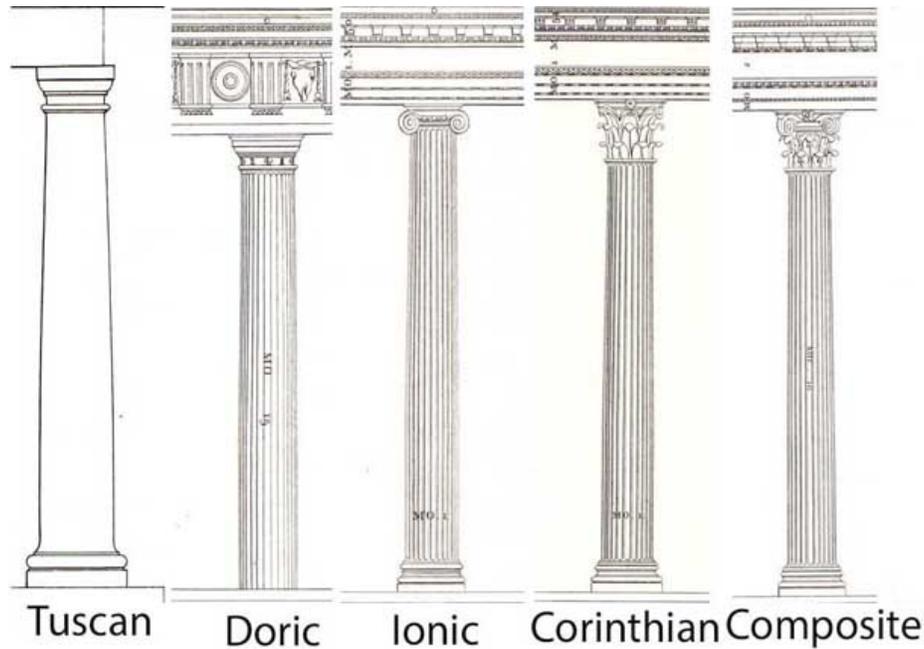
Tetrastyle - four columns

Hexastyle - six columns

Octostyle - eight columns

Decastyle - ten columns

Palladio's Drawings of the Five Classical Orders



Click on drawing for larger size

Source: Dover Books

See also: [Vitruvius Pollio on Doric, Ionic and Corinthian Orders](#) (The Greeks were first to declare that architecture was based on the proportions and form of the human body.)

See also: [Banded column](#) [Caryatid](#) [Clustered column](#) [Colonnade](#)
[Engaged column](#) [Egyptian columns](#) [Hypostyle](#) [Loggia](#) [Peristyle](#)
[Pilaster](#) [Portico](#) [Twisted column](#)

Furniture

An upright member which is taller than it is thick, and serves as a support for something resting on its top.

Examples from Buffalo:

- *Illustration above* - Doric column: [Birge Memorial](#)
- *Illustration above* - Furniture: Empire Pier table (Console table) - [Athenaeum, Philadelphia](#)

- **Banded column:** [Ellicott Square Building](#)
- **Ionic column:** [Albert F. Laub Mausoleum](#)
- **Corinthian column:** [Edward H. Butler Mausoleum](#)
- **Tuscan column:** [Knox House](#)
- **Eastlake cast iron:** [The Granite Works, 844 Main Street](#)
- **Romanesque column:** [St. Francis Xavier RC Church](#)
- **Romanesque twisted column:** [St. John the Evangelist RC Church](#)
- **Gothic column:** [St. Ann's RC Church](#)
- **Queen Anne column:** [Stanton House](#)
- **Queen Anne column:** [Little House](#)
- **Cast iron Corinthian columns:** [Glenny/Dennis/Stanton Building](#)
- **Shaft examples -** [Corinth Greece](#)
- **Fluted shaft on a Doric column -** [Parthenon, Athens, Greece](#)
- **Furniture:** Empire mantel clock - [Amherst Museum](#)

Other examples:

- **Greek Doric column sections -** [Valley of the Temples, Agrigento, Sicily](#)
- **Nasrid Arab columns:** [Comares Palace, Alhambra, Granada, Spain](#)

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| [Home Page](#) | [Buffalo Architecture Index](#) | [Buffalo History Index](#) | [E-Mail](#) |



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Dome



A dome is a convex roof.

Domes are categorized according of the shape of both the **base** and the **section** through the center of the dome.

- The **base** may be circular, square or polygonal (many-sided), depending on the plan of the **drum** (the walls on which the dome rests).
- The **section** of a dome may be the same shape as any **arch**.

Hemispherical dome: circular base with a semicircular section

Saucer dome: circular base and a segmental (less than a semicircle) section

Polyhedral dome; on a polygonal base whose sides meet at the top of the dome

Onion dome: circular or polygonal base and an ogee-shaped section.

Lantern: Many domes have a **lantern** (a turret with windows) to provide light inside.

Cupola: a dome on a circular base, often set on the ridge of a roof (but there are other definitions, also)

Semi-dome: half dome. A common feature of the apse at the end of **Ancient Roman** secular **basilicas**, Semi-domes are a common feature of **apses** in Ancient Roman and traditional church architecture, and mosques and iwans in Islamic architecture.

See also: **Pendentive** for information on the structural support system for domes.

Reprinted from
A History of Architecture on the Comparative Method, by Sir Banister-Fletcher, New York, 1950, pp. 238, 240, 242

Byzantine Architecture

The character of Byzantine architecture, which dates from the fourth century to the present day, is determined by the novel development of the [dome](#) to cover polygonal and square plans for churches, tombs, and baptisteries.

The practice of placing many domes over one building is in strong contrast to the [Romanesque](#) system of [vaulted](#) roofs. The change from Roman and Early Christian forms was gradual, but in the course of two centuries the East asserted its influence; and though no exact line separates Early Christian and Byzantine styles, yet the [basilican](#) type, inherited from pagan [Rome](#), is characteristic of the former, and the domed type, introduced from the East, of the latter...

The [dome](#), which had always been a traditional feature in the East, became the prevailing motif of Byzantine architecture, which was a fusion of the domical construction with the Classical [columnar](#) style. Domes of various types were now placed over square compartments by means of "[pendentives](#)," whereas in Roman architecture domes were only used over circular or polygonal structures.

These domes were frequently constructed of bricks or of some light porous stone, such as pumice, or even of pottery, as at S. Vitale, Ravenna.

Byzantine domes and vaults were, it is believed, constructed without temporary support or "centering" by the simple use of large flat bricks, and this is quite a distinct system probably derived from Eastern methods.

Windows were formed in the lower portion of the dome which, in the later period, was hoisted upon a high "drum" - a feature which was still further embellished in the Renaissance period by the addition of an external [peristyle](#).

The grouping of small domes or semi-domes round the large central dome was effective, and one of the most remarkable peculiarities of Byzantine churches was that the forms of the vaults and domes were visible externally, undisguised by any timber roof; thus in the Byzantine style the exterior closely corresponds with the interior.

Examples from Buffalo architecture:

- Illustration above: [Our Lady of Victory Basilica](#)
- [St. Casimer RC Church](#)

- [St. Vincent De Paul RC Church](#)
- [Blessed Trinity Church](#) - octagonal
- [Our Lady of Lourdes RC Church](#)

Other examples:

- [St. Paul's Cathedral, London, England](#)
- [St. Peter's Basilica, Vatican City, Italy](#)
- [Kirillo-Belozersky Monastery, Goritsy, Russia](#)
- [Church on Spilled Blood, St. Petersburg, Russia](#)
- [Hagia Sophia, Istanbul, Turkey](#)
- Semi-dome - [Hagia Sophia, Istanbul, Turkey](#)

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| [Home Page](#) | [Buffalo Architecture Index](#) | [Buffalo History Index](#) | [E-Mail](#) |

Buffalo as an Architectural Museum

[Illustrated Architecture Dictionary](#)

[Illustrated FURNITURE Glossary](#)

Flute / Fluting

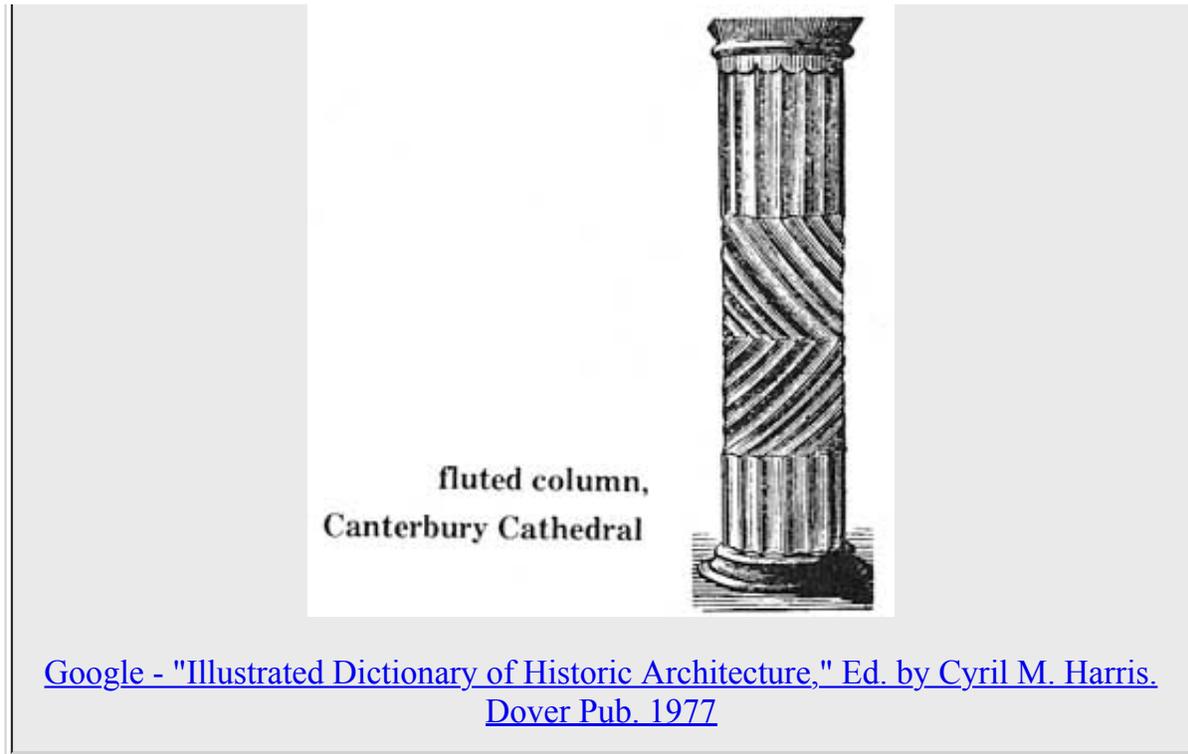
FLU teen



Architecture

Flute: A groove or channel, esp. one of many such parallel grooves usually semicircular or semielliptical in section; used decoratively, as along the shaft of a column.

Fluting: A series of shallow vertical grooves, as on a [column](#)



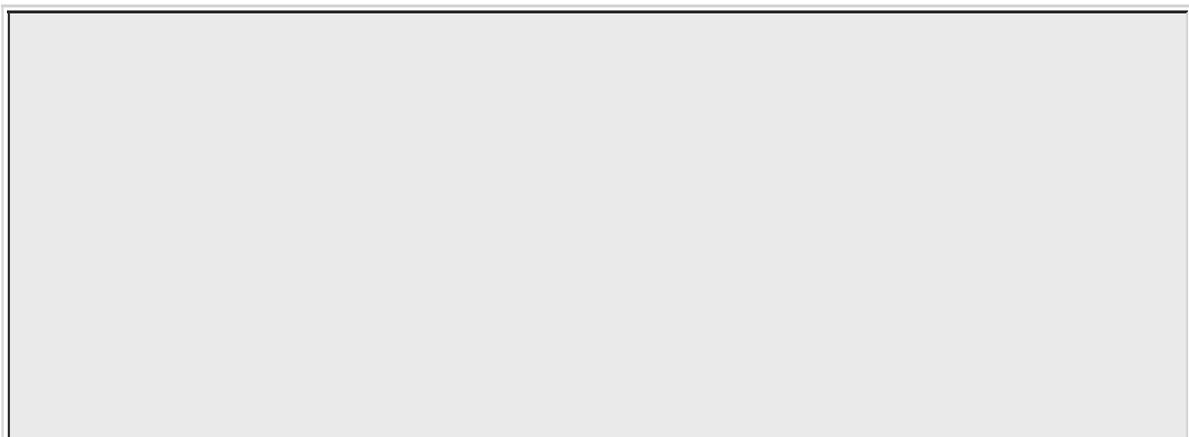
Commonly found on Greek columns (vs. Roman columns where the shaft is usually smooth). For Greeks, fluting may have been a highly stylized memory of wood grain, for the earlier Greek columns were wood (For the derivation of Greek architecture features, see [Greek Architecture and American Buildings](#)).

Fillet (FILL it): the ridge between flutes

Stopped flute: In classical architecture and derivatives, a flute terminated, usually about two-thirds of the way down a column or [pilaster](#). Below this the [shaft](#) may be smooth or faceted, or the fluting may be [incised](#) part way.

Fluted frieze: Flutes decorating a [frieze](#)

Cabled fluting: A molding of convex section formed in the flutes of a column, usually in the lower third of the shaft.





Example, fireplace frieze: [Risman House](#)

"The [Corinthian](#) column is almost always fluted... Even the flutes of a Corinthian column may be enriched. They may be filleted [ridged], with **rods nestled within the hollow flutes**, or **stop-fluted**, with the rods rising a third of the way, to where the [entasis](#) begins.

"The French like to call these **chandelles** [candles] and sometimes they end them literally with carved wisps of flame, or with [bellflowers](#). Example: [Panthéon Paris, France](#)

"Alternately, **beading** or **chains of husks** may take the place of the fillets in the fluting, for Corinthian is the most playful and flexible of the orders. Its atmosphere is rich and festive, with more opportunities for variation than the other orders. - [Crystalinks: Greek Architecture](#)

Commonly found in classical architecture and derivatives: [Greek Revival](#), [Classical Revival](#), [Beaux Arts Classical Revival](#), [Renaissance Revival](#), [Second Empire](#), [Georgian Revival](#) styles

Furniture

Term applied to shallow, hollowed out grooves which are always vertical. They can either run from the top to the bottom of a post, or side by side.

See [scoop pattern](#).

Examples from Buffalo:

- *Left illustration above:* [Buffalo and Erie County Historical Society Museum](#)

- *Right illustration above:* FURNITURE [Ansley Wilcox Mansion / Theodore Roosevelt Inaugural Site](#)
- [Williams-Butler Mansion](#) Exterior Corinthian columns
- [Buffalo and Erie County Historical Society Museum](#) Exterior Doric columns
- [Farrar House, 506 Delaware Ave.](#) Exterior Beaux Arts Ionic columns
- [Niagara Share Building](#) Interior Corinthian pilaster
- [Stella Lowry House](#) Interior Ionic fireplace columns
- [Goodyear House/Oracle Charter School](#) Classic fluting in coved crown molding
- [Margaret Lautz Munschauer House](#) Fireplace architrave
- [Germain House](#) Fluted panel in fireplace frieze
- *Furniture:* Bookcase - [Ansley Wilcox Mansion / Theodore Roosevelt Inaugural Site](#)
- *Furniture:* Server - [Edward Harvey House. 91 Jewett Parkway](#)
- *Furniture:* Reproduction Chippendale English tea table top - [Kittinger Furniture Company](#)

Other examples:

- [Parthenon, Athens, Greece](#) Exterior Doric columns
- [Grand Théâtre, Geneva, Switzerland](#) Exterior Second Empire Corinthian columns
- [Supreme Court Building, Washington, DC](#) Exterior Neoclassical Corinthian columns
- *Furniture:* [Winterthur Museum](#) Fluted stiles, Philadelphia Chippendale side chair

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| [Home Page](#)

| [Buffalo Architecture Index](#)

| [Buffalo History Index](#)

| [E-Mail](#) |



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ArchDaily > Articles > Tensile Structures: How Do They Work and

Tensile Structures: How Do They Work and What Are the Different Types?

07:00 - 18 March, 2018 | by [Matheus Pereira](#)
| Translated by [Guilherme Carvalho](#)



Historically inspired by some of the first man-made shelters—such as the black tents first developed using camel leather by the nomads of the Sahara Desert, Saudi Arabia, and Iran, as well as the structures used by Native American tribes—tensile structures offer a range of positive benefits compared to other structural models.



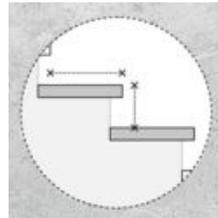
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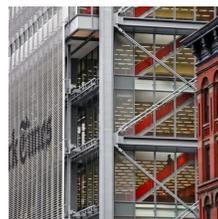
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Tensile structure is the term usually used to refer to the construction of roofs using a membrane held in place on steel cables. Their main characteristics are the way in which they work under stress tensile, their ease of pre-fabrication, their ability to cover large spans, and their malleability. This structural system calls for a small amount of material thanks to the use of thin canvases, which when stretched using steel cables, create surfaces capable of overcoming the forces imposed upon them.

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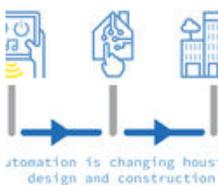


Tensile Structures: 11 Edgy Images Under Strain

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MOST VISITED



The Best Architecture Projects of 2019 According to Time Magazine

Predominantly used in coverings of sports centers, of arenas, and industrial and agroindustrial constructions, tensile structures are based on the old systems used during the Roman Empire. However, from the Roman period until the mid-20th century, due to the low demand, usability, and lack of manufacturers of cables, canvasses, and connections capable of resisting the forces generated, there were few technological advances. It was only after the Industrial Revolution and the triggering of the era of Fordism that new developments were able to meet the intrinsic needs of this construction system. The low cost of mass production and the demand for systems capable of adapting to the most varied terrains with large spans, such as circus tents for example, encouraged the development of the technique.



First Images Surface from Burning Man 2019



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The instability caused in previous models by the application of interlaced cables and very light covers, resulting in structural deficiencies, was solved during the middle of the last century. This was done thanks to a system of steel cables and fiber membranes with a high degree of strength, together with layers of waterproof coatings, giving protection against ultraviolet rays, fungus, fire, and allowing greater or less translucency and reflectivity.

Such progress was only possible thanks to the physical-structural studies initiated by German architect and engineer [Frei Otto](#), who since the 1950s conducted the first scientific studies and the first works of roofing using tensioned steel cables

combined with membranes.

As a student, Otto visited the office of [Fred Severud](#), where he saw the Raleigh Arena in North Carolina and was impressed by the bold aesthetics and propitious comfort of the project. Back in Germany, he began to explore small-scale physical models, empirically generating several surfaces, by means of chains, pulled cables, and elastic membranes.

Convinced by the usefulness of tensioned roofs, he developed the first large-scale project using the system, which later enabled projects including [Olympic stadiums](#), clubs, zoo, and pavilions. In 1957 he founded the Center for the Development of Light Construction in Berlin. Seven years later, in 1964 he created the Institute of Light Structures in Berlin at the University of Stuttgart, Germany.



Author of notable projects passed by experiments and technical refinement, such as the German Pavilion for the 1967 Expo in Montreal and the [Munich Olympic Stadium in 1972](#), the architect is renowned for his intense research work and was honored with the RIBA Royal Gold Medal in 2006 and [the 2015 Pritzker Prize](#). [Frei Otto](#) is still responsible for the first comprehensive book on tensile structures—"Das Hangende Dach" (1958)—and intensified the idea of reinventing material rationality, prefabrication, flexibility and luminosity over internal space, and even sustainability, when the term was not yet used in architecture.

There are three different main classifications in the

field of tensile construction systems: membrane tensioned structures, mesh tensioned, and pneumatic structures. The first relates to structures in which a membrane is held by cables, allowing the distribution of the tensile stresses through its own form. The second case corresponds to structures in which a mesh of cables carries the intrinsic forces, transmitting them to separate elements, for example, sheets of glass or wood. In the third case, a protective membrane is supported by means of air pressure.



Structurally, the system is formalized by combining three elements: membranes, rigid structures such as pole and masts, and cables.

The membranes of PVC-coated polyester fibers have greater ease in factory production and installation; lower cost; and medium durability—around 10 years.



PTFE-coated glass fiber membranes have superior durability—around 30 years; and greater resistance to the elements (sun, rain, and winds); however, they require skilled labor.

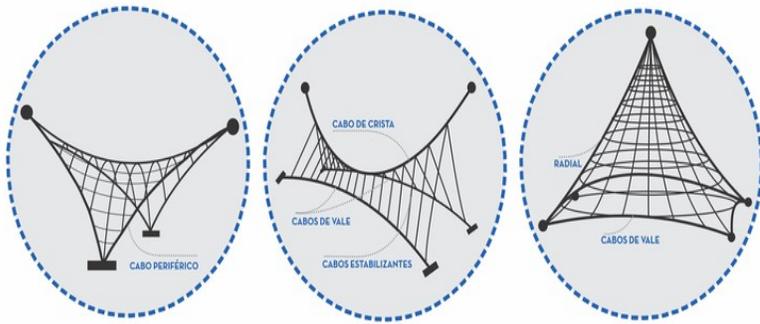


In this system, there are two types of support: direct and indirect. The direct supports are those in which the construction is arranged directly on the rest of the building structure, while the second case is arranged from a raised point such as a mast.

The cables, which are responsible for the distribution of the tensile stresses and the hardening of the canvasses, are classified in one of two ways according to the action which they perform: load-bearing and stabilizing. Both types of cable cross orthogonally, ensuring strength in two directions and avoiding deformations.

The load-bearing cables are those that directly receive the external loads, fixed at the highest points. On the other hand, the stabilizing cables are responsible for strengthening the load-bearing cables and cross the load-bearing cables orthogonally. It is possible to avoid attaching the stabilizing cables to the ground by using a peripheral fixation cable.

Further, some nomenclatures for different cables are generated according to their position: a ridge-line cable refers to the uppermost cable; while valley cables are fixed below all other cables; radial cables are stabilizer cables in the form of a ring. Ridge-line cables support gravitational loads while valley cables support wind loads.



Here are some projects already published on Archdaily using tensile structures:

Munich Olympic Stadium / Frei Otto + Gunther Behnisch



German Pavilion at Expo 67 / Frei Otto + Rolf Gutbrod



**Millennium Dome / Richard Rogers
(RSHP)**



Denver Union Station / SOM



St. Christopher's Pavilion / Sérgio Bernardes



Maracanã Stadium Roof Structure / schlaich bergemann partner



**Brasilia National Stadium / gmp
Architekten + schlaich bergemann
partner + Castro Mello Arquitetos**



References