Supplemental Course Material
Classical Orders

• “The order of a classical building is like the mode or key of classical music. It is established by certain modules like the intervals of music, and it raises certain expectations in an audience attuned to its language. The orders are like the grammar or rhetoric of a written composition.” (Wikipedia).
Classical Orders

• The major components of an architectural column are its plinth, base molding, shaft and capital.
Classical Orders

- The *plinth* is a square or rectangular base for the column.
- The *base molding* forms the base of the column and has different molding profiles.
Classical Orders

- The *shaft*, placed vertically atop the base, is cylindrical and sometimes shaped with vertical hollow grooves or *fluting*.
- The *capital* is the top of the column and has different profiles ranging from simple to highly decorative.
Classical Orders

• Entasis
  – While non-tapered columns are available, most column shafts are produced with the lower one-third straight and the upper two-thirds tapered creating what is known as architectural *entasis*. Attributed to ancient Grecian architects, *entasis* is the slight convex curving of the column shaft that results in a pleasing appearance.
Classical Orders

- While their history dates back to the times of the Greeks and Romans, it was not until the 16th century that architectural writers categorized them as “classical orders” with precise rules as to their proportions and form.
- Architects today are aware of classical orders and column manufacturers identify their products by using classical names. But the days of rigidly adhering to rules regarding dimensions are mostly gone.
Classical Orders

- Distinguished by their proportions and characteristic profiles and details, classical architectural columns are known as the five classical orders of architecture:
  - Tuscan, Doric, Ionic, Corinthian and Composite.
Classical Orders

• Featured in Palladio’s *Quattro Libri di Architettura*, 1570, the Tuscan order is a simplified adaptation of the Doric order by the Romans. It has a very plain design, a simple base and simple capital. Compared with the other orders, the Tuscan order looks the most solid.
Classical Orders

- One of the distinct orders in ancient Greece, the Doric column is the simplest and is characterized by plain, round capitals, a shaft with 20 flutes and no base. The Temple of Hera in Greece dated 600 BC, is the oldest and the best-preserved example of Doric architecture.
- The Roman Doric column has smaller proportions and therefore appears lighter than the Greek version.
Classical Orders

- The Greek Ionic column is distinguished by slender, fluted columns, a large base with two convex moldings and two opposing scrolls in the capital. The classic Ionic shaft comes with 24 flutes and is characterized by an entasis. The base of an Ionic column is often referred to as an Attic base by column manufacturers.
Classical Orders

• The most ornate of the Greek orders, the Corinthian order is characterized by a slender fluted column topped by an ornate capital decorated with two rows of acanthus leaves and four scrolls.

• The shaft of the classic Corinthian order has 24 flutes.
Classical Orders

- The Composite order is a mixed order, whose capital combines the scrolls of the Ionic with the leaves of the Corinthian order. Until the Renaissance it was not ranked as a separate order. Instead it was considered as a late Roman form of the Corinthian order.
Classical Orders

- Specialty Columns
  - Offer additional design options. They may be ordered in plain or fluted columns with capital and base moldings in contemporary, Tuscan, Shaker, Arts and Crafts and other styles.
Column Material Options

- Today, columns are made from wood, stone, concrete and synthetic materials that include fiberglass, cultured marble, resin and fiberglass materials.
- Fiberglass is the most commonly used and the most cost efficient.
Fiberglass Columns

- Fiberglass columns are manufactured from extremely fine fibers of glass used to reinforce polymers known as GRP (Glass-Reinforced Plastic).
- They offer a satisfying combination of modern-day technology and low maintenance care.
Fiberglass Columns

• In this lesson we will review:
  – Advantages of fiberglass over other materials
  – Cast Fiberglass
  – Resin Infusion
  – Filament Wound
  – Pultruded Squares
  – Cellular PVC
  – Splitting options
  – Fiberglass columns that wrap structural supports
Fiberglass Columns

• Advantages:
  – Durable
    • Durability is proportional to the amount of fiberglass use. Some manufacturers, for example, use as much as 40% fiberglass for enhanced durability. Cultured marble generally contains less than 4% fiberglass.
  – Non-porous and waterproof
    • Can be used for both indoor and outdoor applications
Fiberglass Columns

• Advantages:
  – Impervious to termites, staining and decay
  – Unaffected by temperature extremes
  – Unaffected by humidity
  – Will not shatter if dropped
  – Lightweight
    • Less than wood, concrete or cultured marble
    • Easier transportation and installation
Fiberglass Columns

- Advantages:
  - Low maintenance
  - Simple and cost-efficient installation
  - Capable of being cut in a variety of ways. These include:
    - cutting at the bead,
    - cutting to overall length,
    - splitting, and
    - tabbing for reassembly.
Fiberglass Columns

• Cast Fiberglass:
  - Generally formed from molded glass-reinforced polymers.
  - Generally range from 6-in through 20-in in diameter and up to 20-ft in height.
  - Square or round columns may be manufactured from cast fiberglass.
  - Priming and painting with an oil-based or latex coating is necessary after installation.
  - Load-bearing capacity: 8,000—30,000 pounds
Fiberglass Columns

• Resin-Infusion
  – Columns made from E-Glass (an extremely strong fiber), general purpose polyester resins and gel coat resins.
  – Permits column construction without seams or joints.
  – Specifically designed for load bearing applications.
  – Appropriate for projects featuring large exterior columns.
Fiberglass Columns

• Resin-Infusion
  – Weathering is a concern.
    • The polyester resin portion of the composite structure is sensitive to UV exposure.
    • Extended UV exposure can cause color shift or yellowing and gloss changes.
    • Can be overcome by gel coat or paint.
    • UV exposure does not alter or affect the mechanical properties of the column.
Fiberglass Columns

• Resin-Infusion
  – High modulus of elasticity.
  – Excellent compressive strength,
  – Very low coefficient of thermal expansion.
  – Better creep than with other building materials.
  – Superior fatigue properties.
  – Excellent weathering properties when combined with a gel coat or paint.
Fiberglass Columns

- Filament Wound
  - Manufactured using a glass filament-winding method.
  - Process allows for a high concentration of fiberglass and a lower concentration of fillers, providing durability and strength.
  - Appropriate for large exterior columns.
  - Light weight eliminates need for a crane.

[Image of house with Fiberglass Columns]
Fiberglass Columns

• Pultruded Squares
  – Coated fibers are pulled through a die where, under pressure and heat, the resins are cured.
  – Columns manufactured using this process are always square in shape.
  – Pultruded columns cannot be split.
Fiberglass Columns

- Pultruded Squares
  - Will not rot or warp under heat.
  - Resistant to chemicals and moisture.
  - Excellent structural strength and rigidity.
  - Low rate of expansion and contraction.
  - Resists scratches, dings, corrosion, fading and scratching.
  - Pultruded columns cannot be split.
Fiberglass Columns

• Cellular PVC (polyvinyl chloride)
  – A solid, extruded material that has the working characteristics of wood.
  – Weighs about the same as softwood
  – Has a tensile strength of 2,000 to 5,000 psi,
  – Resists deflection up to 150°F.
  – Has a low coefficient of thermal expansion.
  – Becomes brittle below 40°F,
    • Require pre-drilling before cold weather installation, especially near edges.
  – Cellular PVC columns are not load bearing.
Fiberglass Columns

• Splitting
  – Fiberglass columns may be split for a variety of placements on the exterior or interior of a building.
  – Columns can be ordered split by the manufacturer or may be split on site.
Fiberglass Columns

• Splitting
  – Split fiberglass columns can also be to wrap structural supports. Once split, they are no longer load bearing.
  – Manufacturers supply tables that specify the size of round or square columns required to wrap a supporting member.
Wood Columns

• Overview
  – One of the traditional natural materials used for the manufacturing of columns.
  – In this lesson we will review:
    • Features and benefits of architectural wood columns.
    • The different types of woods used
    • Architectural columns
    • Splitting options
    • Surrounding structural supports
Wood Columns

• Features and Benefits
  – Wood columns are produced from finger-jointed board with stave construction.
  – Can be made from virtually every type of wood.

  • Exterior: Western Red Cedar and Clear All-Heart Redwood
  • Interior: paint grade finger-jointed pine or poplar.
Wood Columns

- **Features and Benefits**
  - Numerous cutting options:
    - cutting at the bead, cutting to overall length and altering flute length.
  - Natural wood look for interior applications
  - Staining options include a variety of natural wood colors
  - Finishing options include:
    - prime one coat, prime/sand/prime and applying asphaltum for exterior applications
  - Wood columns can be split and splined for reassembly.
  - Load bearing
Wood Columns

• Splitting
  – Wood columns can be split.
  – Since architectural columns are made to order, most cuts are made by the manufacturer.
  – Specifiers are required to purchase a complete wood column even though only a portion is needed.
Dimensions

- Fiberglass and wood columns come in a wide range of dimensions and lengths.
Manufacturers typically provide dimension and length information in tables like the one reproduced here for cast, resin infusion and filament-wound columns.

<table>
<thead>
<tr>
<th>Size</th>
<th>Bottom Diameter</th>
<th>Neck Diameter</th>
<th>Plinth</th>
<th>Base Diameter</th>
<th>Molding</th>
<th>Capital Square</th>
<th>Round Above Bead</th>
<th>Bead Flute Width</th>
<th>Top Flute Bottom Flute</th>
<th>Number of Flutes</th>
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Resin Infusion and Filament Wound

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<th>Size</th>
<th>Bottom Diameter</th>
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<td>14 1/8&quot;</td>
<td>2 3/4&quot;</td>
</tr>
</tbody>
</table>
Loads

• Load bearing capacity is related to a column’s dimensions and the material it is made from.
• The table shows the capacities of various spun cast and filament wound columns.
• Note
  – Capacities are based on axial – not eccentric – loading.

<table>
<thead>
<tr>
<th>Size</th>
<th>Cast</th>
<th>Resin Infused</th>
</tr>
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<tbody>
<tr>
<td>6&quot;</td>
<td>8,000</td>
<td>*</td>
</tr>
<tr>
<td>8&quot;</td>
<td>10,500</td>
<td>*</td>
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<tr>
<td>10&quot;</td>
<td>13,990</td>
<td>*</td>
</tr>
<tr>
<td>12&quot;</td>
<td>16,000</td>
<td>*</td>
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<td>30,007</td>
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<td>30,007</td>
</tr>
<tr>
<td>36&quot;</td>
<td>*</td>
<td>30,007</td>
</tr>
</tbody>
</table>

1. All load bearing capacities are based on axial loads with no movements.
2. Please consult your structural engineer for wind shear, uplift, and building code requirements for your area.
Loads

• Load bearing capacity – together with other performance characteristics – should be compared for various column types before making a final selection.

• Example:
  
<table>
<thead>
<tr>
<th>Material</th>
<th>Size</th>
<th>Bearing Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament Wound Fiberglass</td>
<td>14”</td>
<td>20,020</td>
</tr>
<tr>
<td>Wood</td>
<td>14”</td>
<td>10,000</td>
</tr>
<tr>
<td>Spun Cast Fiberglass</td>
<td>8”</td>
<td>10,500</td>
</tr>
</tbody>
</table>
• Column products must comply with the relevant state, county or city building codes concerning **load bearing requirements** and **surface burning characteristics**.
Commonly referenced codes include the Standard Building Code, the Florida Building Code, the International Building Code and/or the International One and Two Family Dwelling Code requirements.

Most U.S. cities, counties and states choose the International Codes developed by the International Code Council (ICC).

Note: Some jurisdictions have more rigorous requirements such as Florida’s Miami-Dade and Broward Counties’ High Velocity Hurricane Zone provisions.
Codes

- **Design Loads**
  - determined by ASTM E 72 in Chapter 16 of the Standard Building Code and shall not exceed loads shown in the table below.

<table>
<thead>
<tr>
<th>Nominal Size (in)</th>
<th>Maximum Length</th>
<th>Maximum “e” <em>(in)</em></th>
<th>Allowable Load ‡ (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>10-ft 0-in</td>
<td>1-1/4</td>
<td>16,200</td>
</tr>
<tr>
<td>10</td>
<td>8-ft 0-in</td>
<td>2-1/4</td>
<td>19,100</td>
</tr>
<tr>
<td></td>
<td>12-ft 0-in</td>
<td></td>
<td>18,800</td>
</tr>
<tr>
<td>12</td>
<td>8-ft 0-in</td>
<td>3-3/8</td>
<td>24,600</td>
</tr>
<tr>
<td></td>
<td>16-ft 0-in</td>
<td></td>
<td>17,300</td>
</tr>
<tr>
<td>14</td>
<td>14-ft 0-in</td>
<td>4-1/4</td>
<td>17,100</td>
</tr>
<tr>
<td>16</td>
<td>18-ft 0-in</td>
<td>4-1/4</td>
<td>17,100</td>
</tr>
<tr>
<td>18</td>
<td>8-ft 0-in</td>
<td>4-1/4</td>
<td>30,900</td>
</tr>
<tr>
<td></td>
<td>16-ft 0-in</td>
<td></td>
<td>24,800</td>
</tr>
</tbody>
</table>

*Maximum “e” *(in)* is eccentricity measured in inches from the center line of the top of the column. Eccentric loaded columns assume a nominal 4-in wide wood member installed to transfer axial loads to the column.

‡ Allowable loads are applicable for shorter length columns of the same nominal diameter version.
• **Surface Burning Characteristics**
  – Code compliance requires that column material meet the test requirements of ASTM E 84 (Standard Test Method for Surface Burning Characteristics of Building Materials).
  – Columns must achieve:
    • A Flame Spread Index of less than 25; and
    • A Smoke Developed Index of less than 450, which meets a Class A Interior Finish Rating.
Codes

• ICC Evaluation Service (ICC-ES)
  – A nonprofit, public-benefit corporation that does technical evaluations of building products, components, methods, and materials.
  – Established on February 1, 2003, when America's four building-product evaluation services officially combined their operations.
    • The four "legacy" evaluation services that came together to form ICC-ES were the National Evaluation Service, Inc.; BOCAI Evaluation Services; ICBO Evaluation Service, Inc.; and SBCCI Public Service Testing and Evaluation Services, Inc. Through the legacy evaluation services, ICC-ES has a history that goes back more than seventy years.
Codes

• ICC Evaluation Service (ICC-ES)
  – ICC-ES develops new evaluation reports and maintains a database of “Legacy Reports” from the four evaluation services that joined to form the ICC-ES in 2003
  • All evaluations and reports review data supplied by manufacturers for product code compliance. They are available without charge on the web.
  • A convenient source for specifiers seeking information on column code compliance, specifically for load bearing capacity and surface burning characteristics.
The Subcommittee on Evaluation has reviewed the data submitted for compliance with the Standard Building Code®, the Florida Building Code-Building, and the International One and Two Family Dwelling Code and submits to the Building Official or other authority having jurisdiction the following report. The Subcommittee on Evaluation, and ICC-ES and its staff are not responsible for any errors or omissions to any documents, calculations, drawings, specifications, tests or summaries prepared and submitted by the design professional or preparer of record that are listed in the Substantiating Data Section of this report.

REPORT NO.: 2405

EXPIRES: See the current EVALUATION REPORT INDEX

CATEGORY: MANUFACTURED COMPONENTS

SUBMITTED BY:

maximum size and length shown in Table 1. Non-load bearing columns may be any size and length produced. Column caps and bases are non-structural components that are available in various styles. Dimensions of columns are shown in the manufactures literature.

4.2 Structural

The Stock Fiberglass Columns were tested for structural gravity loads applied axially. Allowable design capacities of the columns were determined using ASTM E 72. Allowable design loads for axial capacity and maximum eccentricity are shown in Table 1.

4.3 Surface Burning Characteristics

Stock Fiberglass Column material was tested for surface burning characteristics under ASTM E 84 and demonstrated a Flame Spread Index of less than 25 and an Smoke Developed Index of less than 450 which meets a Class A Interior Finish Rating.

4.4 Quality Assurance

Quality assurance is provided by Omega Point Laboratories, Inc. of Elmendorf, Texas.

5. INSTALLATION

5.1 General
The Subcommittee on Evaluation has reviewed the data submitted for compliance with the Standard Building Code®, the Florida Building Code-Builder, and the International One and Two Family Dwelling Code and submits to the Building Official or other authority having jurisdiction the following report. The Subcommittee on Evaluation, and ICC-ES and its staff are not responsible for any errors or omissions to any documents, calculations, drawings, specifications, tests or summaries prepared and submitted by the design professional or preparer of record that are listed in the Substantiating Data Section of this report.

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4.2 Structural

The Crown Stock Fiberglass Columns were tested for structural gravity loads applied axially. Allowable design capacities of the columns were determined using ASTM E 72. Allowable design loads for axial capacity and maximum eccentricity are shown in Table 1.

4.3 Surface Burning Characteristics

Crown Stock Fiberglass Column material was tested for surface burning characteristics under ASTM E 84 and demonstrated a Flame Spread Index of less than 25 and an Smoke Developed Index of less than 450 which meets a Class A Interior Finish Rating.
Installation

- Column manufacturers provide detailed instructions for the care, handling and installation of their products.
- They also provide guide specifications to help architects and other construction professionals specify the correct column products for their needs.
- This module presents examples of both types of information resources available from column manufacturers, focusing on round fiberglass columns.
Installation

• The following slides review the step-by-step process for installing a typical round fiberglass column.
  – Although specifics will vary from one manufacturer to another, the basic steps illustrated here – and the relative simplicity of the installation process – will apply to all fiberglass and wood architectural columns.
Installation

1. Drop a plumb bob from the center of the soffit to determine the column's center point on the floor. Mark this point for reference to align the shaft in the proper position.
2. Measure the overall opening height. Raise the soffit slightly with a sturdy brace to allow positioning of the column during installation.
3. Trim the shaft from the bottom with a circular saw equipped with an abrasive cut-off blade. Make final adjustments with a belt sander or rasp. It is very important that the load be evenly distributed around the entire circumference.
Installation

4. Slide the capital over the top of the column shaft allowing it to gently rest on the astragal.
Installation

5. Slide the base onto the column shaft from the bottom. It may be necessary to hold the base in position with tape.
6. Measure the inside opening of the column and install two rust resistant dowels into the floor to prevent lateral movement.
7. As an option, corner brackets can also be used. With the shaft in place, mark and pre-drill the shaft and floor to receive screws and/or toggle bolts.

NOTE: Self-tapping masonry fasteners should be used in concrete floors.
Installation

8. Remove any bracing and allow the load to bear on the column shaft. Make sure the load is centered over the entire circumference of the column shaft.
8...continued

When in proper position:

(a) The top and bottom of the column shaft will fit evenly with the adjoining surface. There will not be any voids or distortions between the shaft and the adjoining surface.
(b) The load will rest evenly around the entire circumference of the column shaft.

NOTE: Do not finish the installation unless both (a) and (b) are achieved.

Correct

Incorrect
9. Slide the capital into place and pre-drill through the capital and shaft. Install with rust resistant screws. Use automotive body filler to cover the screw heads.
10. Attach the base to the column using rust resistant screws. Use automotive body filler to cover the screw heads.
Installation

11. Apply a paintable silicone caulking between the capital and the shaft. (Note: Not all silicone caulking is paintable.)
Installation

12. Apply a paintable silicone caulking between the base and the shaft. (Note: Not all silicone caulking is paintable.)

(Note: If local building codes specify uplift protection, additional hardware is required.)
Specification

• The following slides provide an example of a guide specification for filament wound fiberglass column.
FILAMENT WOUND COLUMNS
SECTION 06500

PART 1 GENERAL

1.1 SECTIONS INCLUDES
A. Fiberglass Columns

1.2 RELATED SECTIONS
A. Section 06100 – Rough Carpentry

1.3 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, protect, and handle products to site per General Conditions.

1.4 SUBMITTALS
A. Submit under provisions of Section 01300.

1.5 WARRANTY
A. Provide limited lifetime warranty to be free from defects in material and workmanship provided the column has been properly installed, to replace or repair any column that has failed as a result of defective material or workmanship.

PART 2 PRODUCTS

2.1 FIBERGLASS COLUMNS
A. All Columns shall be manufactured; utilizing fiberglass filament wound technology incorporating a 97% fiberglass mat content. Minimum load capability of 30,000 pounds. Concentrically loaded. All Columns have an architecturally correct taper and head.

Style: Plain Shaft
1. Diameter: _________
Specification

B. All caps and bases to be fiber-shell or a high-density polyurethane, and fit around a load-bearing shaft.

Style: Tuscan

1. For _______ diameter column

C. Fasteners: Provide fasteners as shown and as required to secure the column, cap, and base for seismic resistance.

D. Acceptable Manufacturer:

PART 3 EXECUTION

3.1 INSTALLATION

A. Set member level and plumb, in correct position.

B. Assure load is evenly distributed over the bearing surface of the column shaft.

C. Rejoin the shafts of the split column using construction adhesive and apply to all surfaces to be joined.

D. Align halves around the post or structural support and join together. Clamp and tighten uniformly until adhesive sets.

E. After adhesive sets, remove the clamp or strap and rough sand with 80 grit and finish sand with 120 grit or finer sandpaper.

F. Use an epoxy adhesive to glue the cap and base halves together.

G. A fiberglass repair kit may be used as filler. Follow the instructions.

3.2 FINISHING

A. Remove all dust and dirt from surface by wiping with mineral spirits prior to painting.

B. DO NOT USE paint or solvents containing acetone.

END OF SECTION