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The Charleston Trussed Roof: A Study of the Development and Implementation of a Structural Solution from 1740-1820

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THE CHARLESTON TRUSSED ROOF:
A STUDY OF THE DEVELOPMENT AND IMPLEMENTATION OF
A STRUCTURAL SOLUTION FROM 1740-1820

A Thesis
Presented to
the Graduate Schools of
Clemson University and the College of Charleston

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
Historic Preservation

by
Pamela Marotta Kendrick
May 2013

Accepted by:
Dr. Carter L. Hudgins, Committee Chair
Ralph Muldrow
Dr. Carl Lounsbury
Willie Graham
ABSTRACT

Charleston, South Carolina is renowned for the impressive churches, civic buildings, and mansions which line its historic streets. Although scholars have studied many of these famous structures in depth, the roof framing methods used to construct these large buildings has rarely been studied or documented. Where documentation exists it is rudimentary at best, often only identifying the overall form of the roof or the material used for the roof covering. The truss roof system was designed to accommodate buildings with a spans greater than twenty five feet wide. The implementation of these truss roof designs enabled the construction of Charleston icons such as St. Michael’s Church, the Courthouse, and the Nathaniel Russell House. A greater understanding of the truss roof forms used is thus needed to gain a holistic understanding of the construction technologies employed to create the buildings for which Charleston is so famous.

This thesis identifies the truss roof forms implemented in Charleston from 1740-1820. For each truss roof form identified, European design influences are discussed and a description of the truss’ structural behaviors are provided. Additionally, each truss roof identified in this study is documented and closely examined for a unique provincial style. While this is not an exhaustive study of all existing resources built within the timeframe specified, the findings of this study present an essential first step in establishing a comprehensive understanding of the Charleston building tradition in the eighteenth and early nineteenth centuries.
DEDICATION

To my husband Logan, whose unwavering love and support guided me each step of the way.
ACKNOWLEDGEMENTS

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I am grateful to Craig Bennett of Bennett Engineering for his professional expertise and for going out of his way to assist me in my research. A special thank you is owed to the archivists and staff at various Charleston research institutions including the Charleston Museum, the South Carolina Historical Society, and Historic Charleston Foundation. The incredibly gracious homeowners, city staff, and facility managers who provided unrestricted access that allowed this thesis to become a reality cannot go without mention.

I cannot thank my classmates enough for their support and friendship over the last two years. All of my classmates contributed to the success of this thesis, especially my fearless documentation assistants Liz Shaw and Laurel Bartlett, and I am blessed to have each of you in my life. I’d like to express my gratitude to my sister, friend, and editor Beth whose help was invaluable to me. Last, but certainly not least, I am so thankful for my husband, family, and friends who have encouraged me through the entirety of this journey.
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CHAPTER ONE
INTRODUCTION

The trussed roof was a critical advancement in seventeenth century British building technology in the Anglo-American world. A truss roof is defined as a roof system in which one or more timber members, acting in tension, help to support the building span. The truss roof replaced traditional roof forms such as common rafter roofs, principal rafter roofs, and M-roofs. This new roof structure accomplished previously difficult architectural feats; it enabled the construction of greater building spans, facilitated complex and fashionable architectural roof forms and allowed for large, open interior spaces. The earliest use of the trussed roof in England was in the seventeenth century and its use and popularity has been studied and documented in various forms. Interestingly, many of Charleston’s most notable structures feature trussed roof technology. However, despite the importance of the truss roof in the construction of some of Charleston’s most prominent buildings, little research has been conducted on the subject. The intention of this thesis is to provide a study of the evolution of truss roof technology and its applications in Charleston between 1740 and 1820.

The origins of the trussed roof have been traced to Italy where variations of king and queen post trussed roofs appeared in sixteenth century illustrations by Italian designers such as Andrea Palladio and Sebastiano Serlio. In the seventeenth century English designers like Inigo Jones and Christopher Wren used trussed roofs in high-profile notable buildings, especially churches. Although it is unclear how the trussed roof designs were

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transmitted from Italy to England, drawings in Jones' journals and Roman sketchbook suggests he might have learned of the trussed roof while traveling through Italy. Of the two English designers, Jones was the first to implement a trussed roof for his design of Queen's House, constructed in Greenwich, England, in 1616-1619. Jones most commonly used variations of the king post truss in his designs, while Wren employed both king and queen post trussed roofs in the designs of his churches. Scottish architect James Gibbs, who was trained in Italy, has also been credited with the dissemination of the Italian trussed roof concept in England. Gibbs published the _Book of Architecture_ in 1728, which explicitly illustrated Italian roof truss designs for use by English architects and carpenters. The development of the king post trussed roof is documented through the works of Jones and Gibbs, but the development of the queen post is less clear. Early eighteenth century publications like those by Francis Price and Batty Langley illustrate queen post truss designs, but for reasons yet unknown, this roof form did not become popular in England until the second half of the eighteenth century.

Knowledge of these trussed roof forms arrived in the British colonies through a variety of methods. A number of architectural pattern books and carpenter’s manuals published by the 1720s depicted a number of trussed roof designs. Many of these pattern books and trade manuals were available for reference by local contractors and carpenters. In addition, English craftsmen visited or immigrated to the colonies, bringing their local building traditions with them.

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3 Yeomans, _The Trussed Roof_, 30-32.
The trussed roof was developed to accommodate the seventeenth century changes in architectural forms and building types that traditional frame roof construction could not support. The first of these changes was the need to accommodate a general increase in the span of the buildings. Until the development of the trussed roof a building’s span, or width, was limited to approximately thirty five feet without the use of extraordinary engineering. The size of available timber limited the building span traditional framed roofs could accommodate. In a trussed roof the weight of the framing and covering is transferred to large tie beams and purlins, thus negating the need for a number of oversized, inordinately long and heavy common rafters. Common rafter roofs are capable of achieving spans up to twenty five feet, while principal rafter frame roofs are capable of supporting spans up to thirty feet, before they become structurally inefficient because the deflection in the tie beam becomes too great. The king post trussed roof could achieve a building span up to forty five feet, while the queen post and king-and-queen post trussed roofs could achieve building spans in excess of seventy feet. These great spans were accommodated with the use of timbers that were no larger or longer than those used in traditionally framed roof construction.5

In addition to building span, the trussed roof was developed to accommodate the weight of the heavy plaster vaulted ceilings that came into fashion. Open ceilings in which the roof framing members were exposed to interior spaces were replaced with decorative plaster ceilings that concealed the roof structure and added a substantial amount of weight to the roof framing system. Therefore, large scantling, such as tie beams and girders, were employed to carry the weight of the decorative ceilings. Vaulted ceilings became a desirable architectural feature in many churches, civic, and residential buildings, and were often

constructed over vast meeting spaces or ballrooms. Unlike a trussed roof, traditional framed roofs were not capable of supporting the weight of these heavy plaster ceilings.  

Stylistic changes in architecture demanded adaptations of existing construction techniques and precipitated the need for new planning arrangements of interior spaces. New architectural styles were also reflected in changes in roof pitch from steep slopes to pitches of forty-five degrees or less. The adoption of the trussed roof also enabled the construction of the types of shallow roof pitches that were critical to the successful use of these increasingly popular forms. Developments in building layouts shifted away from small, separated rooms towards large, individual spaces. The development of the trussed roof could compensate for the absence of interior load-bearing walls because the tie beam was supported through king or queen posts rather than interior partition walls.  

The development of the truss roof in England has been researched extensively by historian David Yeomans. However, relatively little research has been conducted on the development of the truss roof in England or in early America outside of Yeomans work. Virtually no research has been conducted on the Charleston truss roof. Yeomans, an expert in English timber-framing methods, conducted a preliminary study on “English” roofs in colonial America. His exploration of American roofs further aimed to understand the degree to which British carpenters influenced the building practices of the New World. His study surveys roof typologies in the New England area where he focused on Massachusetts and Rhode Island. Yeomans also examined roof forms in the Philadelphia area, Louisiana, and Virginia. Charleston, South Carolina is noticeably absent from the survey with the

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6 Yeomans, The Trussed Roof, 26-27.
7 Yeomans, The Trussed Roof, 32.
exception of St. Michael’s church. Due to the lack of research previously conducted, the current understanding of seventeenth and eighteenth century truss roof design is largely based on the work of Yeomans. Therefore, the observations made in this study will be compared primarily to Yeomans research.

Charleston served as the “epicenter of urban life” in the Lowcountry in the colonial period. Fueled by the success of the rice and indigo staples, Charleston became a wealthy and thriving sea port through which slaves, English craftsmen, and imported goods flowed continuously. By the mid-eighteenth century a wealthy planter-merchant elite class had emerged. This group quickly transformed Charleston from a fledgling colonial town to a small thriving metropolis. Charleston contributed to the overall expanse and financial success of the American colonies. Over the course of the eighteenth century, Charleston grew to become the fourth-largest town in mainland British America. The population of the town had increased fourfold within a fifty year period, allowing the population of the city to surpassed that of Boston and practically equal that of New York by 1775. Only Philadelphia upstaged Charleston in this regard. This era of success, which began in the 1730s and continued for nearly one hundred years, was coined by historian Emma Hart as the “golden age of commerce”. During this period Charlestonians constructed some of the most architecturally significant structures in colonial America, such as the Miles Brewton House, St. Michael’s Church, and the Exchange.

This study addresses the fundamental questions surrounding the truss roof system in Charleston including when the truss roof was first constructed in Charleston, what

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10 Hart, Building Charleston, 1-5.
influenced the design, what types of trussed roofs were constructed, and how rapidly the
new construction technology spread throughout the city. The intent of this thesis is to
answer such questions through a comprehensive study of trussed roof designs and their
application in Charleston. The proliferation of the trussed roof and its design variations in
this southern city was determined primarily through site visits. The results of this study are
presented through written summaries, measured drawings, and photographic
documentation. Subsequent sections of this thesis define various trussed roof designs and
their structural components. An overview of the history and development of the British
trussed roof forms provides a point of comparison between the trussed roofs constructed in
Charleston and those in England. Preliminary information on other colonial American
trussed roof designs provides an additional point of comparison to Charleston trussed
construction. Through these comparisons regional and local variations in trussed roof
design are highlighted.

Charleston is a critical case study in the development of American roof forms. The
city’s wealth and prosperity necessitated the construction of many large public and private
buildings, the size and scale of which were arguably unrivaled in other colonial cities. One
could argue that these socio-economic factors placed the city at the leading edge of
construction technology. Therefore Charleston is a critical component in the development
of American building forms and the roof framing technologies that enabled the construction
of these modern structures.
CHAPTER TWO

METHODOLOGY

The main objective of this study is to analyze the types of trussed roofs constructed in Charleston, South Carolina during the period of its rapid growth and rising prosperity in the eighteenth and early nineteenth centuries. To determine eligibility of properties for inclusion, the characteristics of the trussed roof and its variations were defined and a standard terminology was established. Then, the size and integrity of each surviving building from the time period was evaluated to determine the likelihood of trussed roof construction.

This study focuses on the proliferation of truss roof construction in Charleston from 1740-1820. The timeline chosen is reflective of Charleston’s “golden age of commerce,” which began in the 1730s with the success of the rice industry and continued for nearly one hundred years.\(^1\) During this time, the success of the agricultural and mercantile industries transformed Charleston from a small walled city into a thriving urban metropolis. Although the 1730s marked the beginning of this century of success, this thesis will focus on truss roofs constructed after 1740. In 1740, a devastating fire ripped through the Charleston peninsula destroying over six hundred buildings in the most populated area of town including residential, commercial, industrial, and ecclesiastical structures.\(^2\) The effects of the fire, coupled with other natural disasters, wars, and subsequent alterations meant that for structures constructed before 1740 few survived. The fire created a great need to

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rebuild the shops, stores, warehouses, and residences that were lost in the disaster. A large influx of carpenters and bricklayers immigrated to the colony after the fire to meet this demand, many of whom arrived from England and Ireland. The trade practices and technologies these tradesmen brought from England merged with local traditions to create the built landscape that is now recognizable from this era.³

Between 1740 and 1820 Charleston experienced tremendous growth. The city evolved into the cultural and religious center of the South, and became a pivotal location for transatlantic trade. A comparison of the 1739 *Ichnography of Charles Towne at High Water* (Fig. 2.1) and the 1788 *Ichnography of Charleston* (Fig. 2.2) illustrates the expansion of the city over the course of fifty years. Although a series of wars, natural disasters, and epidemics plagued the city, Charleston remained a provincial cultural center in the British Atlantic urban system throughout the 18th century. In the first quarter of the nineteenth century, the city experienced economic stagnation. The War of 1812 catapulted the city into an enduring economic depression.⁴ By 1820 Charleston’s population had dwindled and new construction slowed.⁵ To achieve the maximum survey size, this thesis examines existing buildings constructed in the decades between 1740 and 1820. This time period reflects Charleston’s economic golden age, which resulted in the greatest expansion of the city’s built environment.

⁵ Rogers, *Charleston in the Age of the Pinckneys*, 3-6.
Figure 2.1: *The Ichnography of Charles Towne at High Water, 1739*, depicts the city's expansion before the Fire of 1740, which destroyed over 600 buildings. (Historic Charleston Foundation)

Figure 2.2: *The Ichnography of Charleston, 1788*, depicts the built environment of the city at the peak of economic, political, and social success. (Library of Congress, www.loc.gov)
Establishment of consistent terminology prior to the formation of a survey database was paramount to the success of this study. The nomenclature used to describe roof construction reflects historic precedence, the time period, and the local dialect. Many sources consulted for this study exhibited inconsistencies in nomenclature or discrepancies in the definitions of terms, making it difficult to compare concepts and findings.

One such discrepancy is the definition of a truss roof. The definition of a truss provided by Carl Lounsbury in An Illustrated Glossary as “a rigid triangular framework consisting of chords, struts, and other supporting members,” is a commonly accepted description. This definition would have application in early traditional roof forms like the common rafter roof, principal rafter roof, and the M-roof, as well as the later king post, queen post, and king-and-queen post trussed roofs.

Historian David Yeomans presents a narrower definition of a truss in which the supporting members act in tension thereby creating a “trussing” action on critical structural members like the tie beam. Under Yeomans' definition, these traditional roof forms such as the common rafter roofs, principal rafter roofs, and M-roofs would no longer be categorized as a truss roof. He suggests the use of “frame” to describe these roof types as the supporting posts act in compression and therefore, no trussing action on the tie beam occurs.

The language with which structural composition of the roof framing members is described must be clear in order to discuss and examine the engineering solutions provided by the roof frame. Therefore, it is necessary to establish distinct differences in the structural behavior of early roof forms, like the common rafter roof, and later developments.

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like the king- and queen-post trusses. This distinction will be identified through the adoption of Yeomans’ terminology. Traditional roof structures in which the supporting posts are placed in compression will be defined as ‘frames’ and the term ‘truss’ will be reserved for roof structures in which the supporting posts act in tension.  

The survey process began with the development of an inventory of eligible buildings. In order to determine which roof systems should be analyzed for this thesis, a database was created in Microsoft Office Access. Criteria for the database included date of construction, building span, and integrity of the roof frame. The first step in locating trussed roof buildings was to determine how many buildings constructed between 1740 and 1820 survive. Information was derived from a number of sources written about Charleston buildings, such as Jonathan Poston's Buildings of Charleston, in order to compile a list of surviving structures built between 1740 and 1820. Each surviving property was entered into an Access database and information such as the property name, address, and construction date was recorded. This method of data collection identified 184 surviving properties in Charleston that were constructed in the timeframe specified.

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9 Microsoft Office Access is a database management program designed for the collection of data and the subsequent analysis of that data.
10 Sources that provide written information on the Charleston buildings and their period of construction were referenced. This method has likely resulted in the exclusion of less known existing structures of the time period. Further study should be conducted for a complete list. For the purposes of this study information from the following sources were compiled to create a list of surviving buildings erected between 1740 and 1820: Jonathan H. Poston, The Buildings of Charleston: A Guide to the City's Architecture (Columbia, SC: University of South Carolina Press, 1997); Carter L. Hudgins, Carl R. Louonsbury, Louis P. Nelson, and Jonathan H. Poston, The Vernacular Architecture of Charleston and the Lowcountry, 1670-1900: A Field Guide (Charleston, SC: Vernacular Architecture Forum, 1994); Nelson, Louis P. The Beauty of Holiness: Anglicanism and Architecture in Colonial South Carolina (Chapel Hill, NC: The University of North Carolina Press, 2008); Kenneth Severens, Charleston Antebellum Architecture and Civic Destiny (Knoxville, TN: University of Tennessee Press, 1988); Gene Waddell, Charleston Architecture, 1670-1860, Vol. 1 (Charleston, SC: Wyrick and Company, 2003).
Exterior measurements of each surviving building were obtained through existing measured drawings from the *Historic American Building Survey* (HABS), field measurements, or from *Pictometry*. Historically, truss roofs were a necessary structural solution to building spans greater than thirty feet, although variations of truss roof systems have been documented in buildings with spans of twenty seven feet. To ensure all potential truss roof systems were included in the database, each surviving structure with a building span greater than twenty five feet was included in the database for further study. In addition to structures with a building span greater than twenty five feet, ten buildings with spans less than twenty five feet constructed were identified for inclusion in the study. A field inspection of these structures with modest building spans was necessary to gain a contextual understanding of the various roof framing methods implemented in Charleston at this time.

For each of the 184 properties identified, exterior measurements were recorded in the *Access* database. A query of properties with a building span greater than twenty five feet produced ninety eight properties with potential trussed roofs. The addresses of these eighty three properties were confirmed through parcel data provided on Charleston County GIS maps, and then plotted on a map created in *AutoCad 2012* (Fig. 2.3). Not identified on the map are Mulberry Plantation and Hampton Plantation, both of which were included in the study to determine if there was a distinction between the framing techniques employed in rural plantation houses and those used to build urban structures.

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11 *Pictometry* is an aerial image capture process that produces images of buildings that can be measured through the program. Field measurements were taken on five buildings for which measurements were obtained through *Pictometry* to verify the accuracy of the measurements provided by the aerial images. The field measurements proved that measurements taken from *Pictometry* were within six inches of the actual building measurements.

12 Mulberry Plantation was an early eighteenth century structure, the roof framing structure was replaced in the late eighteenth century.
Figure 2.3: Surviving properties constructed between 1740 and 1820 with a building span greater than 25 feet are identified in grey, while buildings investigated as part of this thesis are identified in black. Mulberry Plantation and Hampton Plantation were included in the study but are not represented on this map because they are located outside of the greater Charleston area. (Map illustration by author)
The primary research method used for the completion of this study was first-hand observations through site investigations. A survey data form was created in *Access* to record information on-site including the exterior building measurements, the interior attic measurements, the height of the roof ridge, the pitch of the roof, and the type of trussed roof form constructed. A framing schedule that lists typical members was created and included structural members such as the principal rafters, common rafters, tie beams, floor joists, false plates, collar ties, king or queen posts, struts, and purlins. For each timber framing member, the dimensions, method of preparation, wood species, joinery methods, and spacing was recorded. This information was entered into an *Access* database for further analysis.

Properties that exemplified specific trussed roof types or showcased unique structural conditions, are highlighted through measured drawings and sketches. For each trussed roof type, one property was chosen and a section cut of that building was drawn in *AutoCad 2012* using the field measurements obtained from the site visit. Three-dimensional models were created using *SketchUp* for two surveyed properties, 39 Church Street and 87 Church Street, both of which present unique structural characteristics.

Secondary sources, such as existing drawings, newspaper ads, company records, and personal histories were consulted to supplement the information obtained from field observations where obtainable. Original design drawings provided by local libraries and historic societies were used as a means of understanding the types of designs familiar to craftsmen at the time the structure was built, and as an approximate estimation of the designer’s intentions for the design. Existing measured drawings were used only as a guide because discrepancies were often found between the measurements recorded on paper and the measurements found during site investigations. Additional written records pertaining to
the roof designs are occasionally available in the form of building contracts, carpenter’s bills, and historic structure reports. Like the design drawings, these documents rarely paint a complete picture of the roof form and its construction. The inconsistencies found within existing drawings and the incomplete data provided in written documents further emphasize the need for reliance on field observations for this study, an observation that Yeoman also noted with his work in England.13

The survey results presented in this thesis document and analyze existing trussed roofs in Charleston through written reports, measured drawings, photographs, and framing schedules. The results of this study provide the first comprehensive analysis of the Charleston truss roof. The observations made were used to categorize the various truss roof forms constructed and to identify the style and function of each truss form in Charleston from 1740-1820. Additionally, this study is intended to compare the commonality of this roof typology to other roof framing methods used during the time period. The frame roofs examined for this study include common rafter roofs, principal rafter roofs, and M-roofs. The truss roof forms are categorized as a king post truss, queen post truss, king-and-queen post truss combination, or a raised tie beam truss.

13 David Yeomans. The Trussed Roof, 7-8.
CHAPTER THREE

ROOF FRAMING TYPES PRECEDING THE TRUSS

In 1739 Bishop Roberts painted a watercolor of Charleston's Cooper River waterfront in which he captured a city on the verge of significant change. From Craven’s bastion on the city's southern edge north, the gable ends of houses faced the river. Only a few of the buildings Roberts drew would survive the hurricanes, fires, and earthquakes that lay ahead. The dwellings drawn by Roberts reflected a variety of British architectural traditions used by American colonists in the Chesapeake, New England and the Mid-Atlantic.

Dwellings with parapeted stepped and curvilinear gable ends like the ones Roberts captured would soon disappear, replaced by newer, more stylish forms. Under the tiles and shingles that shed Charleston's already famously heavy rains, were timber roofs that revealed how builders calculated the loads of shingles and tiles, how they spanned the domestic and commercial spaces that lay below, and how they determined the best pitch. At first glance Charleston’s roofs might look at home in Massachusetts or Virginia. Closer inspection, however, reveals how Charleston’s builders responded to local conditions and in doing so made adjustments, some small and some large, that distinguished Charleston’s roofs from others.
Figure 3.1: Bishop Robert’s *An Exact Prospect of Charles Towne, the Metropolis of the Province of South Carolina, 1739* as engraved by William Tomis. (Charleston County Public Library, South Carolina Room)

Figure 3.2: A close-up of Bishop Robert’s 1739 watercolor details the variety of rooflines constructed along the Cooper River in Charles Towne. (Historic Charleston Foundation archives)
This chapter explores the traditional frame roof technologies used by Charleston builders from the early eighteenth century into the nineteenth century. Frame roofs such as common rafter roofs, and principal rafter roofs were employed for the construction of the relatively small structures with building spans less than thirty feet, whereas M-roof forms were used for larger building spans. Common rafter roofs proved long-lived and durable in application, especially for the construction of Charleston single houses. The principal rafter roof, like the common rafter roof, would continue to be used for the construction of structures with modest building spans, particularly residential buildings. Unlike other traditional frame roof forms, the M-roof design was soon replaced with a better structural solution for the construction of large building spans.

A number of factors influence a building’s span and roof type including the roofing material, climactic conditions of the region, the intended use of the structure, and the architectural style of the structure. Geographical location can influence architectural style, building material, and roof pitch. The engineering solutions adapted to suit regional circumstances are evident when comparisons between the colonial American colonies are made. Charleston craftsmen found several methods to overcome local limitations to frame impressive structures that represented the wealth and success of the colonial city between 1740 and 1820.

The choice of roof covering was largely determined by the materials that were locally available. The weight of these materials influenced the pitch required, which in turn determined the type of structure used to support the roof.¹ In colonial America the most readily available building material was wood. Therefore, the typical roof covering was wood shingles, although slate and clay tiles were also used. The use of wood shingles had a direct

impact on the design of many Charleston roofs because of their weight and size. Wood shingles weigh less than slate ones, so the timber framing members used could be smaller in size for roofs covered with wood shingles than those scantlings required to support heavier roof coverings. What transpired was a Charleston roof design that included closely spaced, lightweight timbers.

Climactic conditions also affected the design of the roof structure. For dry, arid climates a low slope roof was acceptable practice. For areas that received heavy rain or snowfall a steeper pitch was required to shed the weight of the precipitation quickly. Whereas New England roofs typically had steep pitches of forty five degrees, the warm South Carolina climate allowed Charleston to implement the shallow pitched roofs of thirty degrees or less that were fashionable at the time.\(^2\)

Another factor that dictated the type of roof framing constructed was the intended use of the structure. The building’s use was often the driving force behind the size and layout of the structure. Churches, warehouses, and large residences typically required large open spaces that were void of any internal support mechanisms such as load bearing walls or columns. This open space was necessary for worship, work, or entertainment. Residential and commercial building often required less space so the building footprints were smaller. Additionally, the interior spaces of these buildings were typically divided into smaller rooms by partition walls, which could help support the load of the roof, thereby reducing the size and span required of the roof timbers. Traditional framing methods were limited to a span of about twenty five feet, although spans up to thirty feet wide could be achieved if partition walls were used for the interior spaces.\(^3\)

Popular architectural style directly impacted the roof profile of a building, which in turn affected the type of roof framing method used. English design, like those of Inigo Jones and Christopher Wren, greatly influenced the profile of the roofline in Charleston. The British design preference for pedimented gables became a popular aesthetic in colonial America during the eighteenth century. The framing methods required to achieve the thirty degree pitch and pedimented gables that were associated with the new styles were varied and complex. Although these earlier roof forms were eventually replaced by simple truss forms like the king post and queen post roofs, an examination of these traditional frame roofs provide a comprehensive understanding of framing technologies available in South Carolina during the eighteenth and nineteenth centuries.

**Common Rafter Roofs**

The common rafter roof was the simplest traditional frame construction technology recorded in Charleston. This design is comprised of pairs of rafters joined at the ridge of the roof. In this design, the rafters exert an outward-thrust on the wall plates on which the rafters stand, except in the smallest spans. The building span is inversely proportional to the rafters’ tendency to sag under the weight of the roof covering. These inherent design flaws were compensated with a number of simple techniques that were commonly found throughout the Charleston region.

To prevent bending in the rafters from the weight of the roof covering several methods of strutting were adopted. The typical method was the installation of collar ties between the principal rafter pairs. Collar ties are joined into the common rafters in a number of ways including pegged mortise-and-tenon joints and half lapped dovetail joints.

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4 David Yeomans "Inigo Jones’s Roof Structures," 85.
The simplest connection was formed when the collar tie was butted and nailed to the common rafters. In Charleston, examples of each of these joinery methods have been found. Common rafter roofs generally rely on the use of lightweight joists or tie beams to help support the weight of the roof as well as to restrain the tops of the walls from buckling or thrusting outward. Tie beams were placed at intervals and fixed to the wall-plate, commonly with a half lapped dovetail joint. This connection helps resist the outward movement of the wall plates caused by thrust from the rafters. This joint was eventually replaced with a simpler method of simply half lapping the tie beam over the wall plate.\(^6\)

\textit{47 East Bay}

Constructed in the 1740s, the Anne Boone House, located at 47 East Bay Street, is a three-story stucco covered masonry building.\(^7\) Hipped ends replaced the original gabled ends of the frame roof in the nineteenth century. The center portion of the earliest roof remains intact. The rafters at 47 East Bay Street are spaced 1’-4 ½” on center and measure 4”x 5 ¾” in size. The uniform size of the rafters would suggest the frame is a common rafter roof, but the joint connections reveal the structural behavior of this frame roof more closely resembles that of a principal rafter roof.

For the rafters that behave structurally like common rafters, their feet are butted and nailed to a false plate. The tops of the rafters are mortised-and-tenoned together and secured with a peg. Collar ties, located at the mid-point of the common rafters, are dovetailed into the rafters and secured with nails. Here, every third, or fourth, common rafter acts as a principal rafter. The feet of these rafters are mortised-and-tenoned into tie

\(^6\) Yeomans, \textit{The Trussed Roof}, 19.
beams that sit on top of the wall plate. Collar ties span between these rafters at the mid-point and are connected with a pegged mortise-and-tenon joint.

The different joinery techniques used in the construction of the frame roof at 47 East Bay Street indicate a basic understanding of structural behavior. However, to understand the intent behind the design of the frame roof, further study is required.

**Figure 3.3**: Collar ties are joined to the common rafters at 47 East Bay Street with a half lapped dovetail joint and secured with nails. (Photograph by author)

**Figure 3.4**: A 3D Model depicts original common rafters in blue. White common rafters are a later addition that reflects the change from a hipped roof to a gable roof. (Drawing by author)
Figure 3.5: Collar ties are connected to every third or fourth common rafter with a pegged mortised-and-tenoned connection. (Photograph by author)

Aiken Rhett House

The Aiken Rhett House was constructed around 1820 at 48 Elizabeth Street for John Robinson, a prosperous merchant. The large residence was built as a typical Charleston double house plan that contained a central passage with two rooms on either side of it. The building span at twenty five feet was covered with a common rafter frame roof.

On average, the Aiken Rhett common rafters measure 2 ¾" x 6", spaced 1'-5" on center. At the ridge, the common rafters are mortised-and-tenoned together and secured with a single wooden peg. At the feet, the common rafters are butted and nailed to a false plate that is approximately 1" thick. Collar ties measuring 3" x 5 ½" strut between each rafter pair at the midpoint of the common rafters. The collars are mortise-and-tenoned into each rafter pair and secured with a single peg.
Figure 3.6: Common rafters are mortised-and-tenoned together and secured with a single peg along the ridge of the roof at the Aiken-Rhett House. The hipped ends are created by using hip rafters the same size as the common rafters. These hip rafters are butted and nailed to the adjoining common rafter pair. (Photograph by author)

Figure 3.4: The collar ties in the Aiken Rhett House are mortised-and-tenoned into the common rafters and secured with wooden pegs. (Photograph by author)
Principal Rafter Roofs

The inclusion of purlins in principal rafter roofs prevented bending in the common rafters. Purlins are large horizontal members that carry the load of the roof for the common rafters and transmit the weight to the principal rafters. They require support from a frame that acts as a truss in which triangulation occurs because the principal rafters are tenoned and pinned to the tie beams. In most cases these supporting frames are larger than the rest of the rafters and are called principal rafters. The principal rafter pairs were commonly strutted with collar ties and spaced at regular intervals. It was common in Charleston to taper the principal rafters so these framing members would be smaller at the ridge. This was done in order to lighten the roof and limit deflection along the lengths of the rafters. This construction details bears resemblance to eighteenth century frame construction in the Chesapeake where rafters were tapered in the construction of finer buildings.\(^8\)

The most common purlin arrangement consisted of one purlin, placed halfway up the rafters, although instances where two or three purlins are used have been found in buildings with large spans. The rows of purlins are typically staggered between the sets of principal rafters. There are a number of ways in which purlins can be fixed to the principal rafters. “Clasped purlins,” a common English type, involve a purlin clinched between the collar and the principal rafter.\(^9\) This connection allows the principal rafter to be in the same plane as the back of the common rafters. The simplest form of connection is a trenched purlin. When a purlin is trenched it passes over the back of the principal rafters which are

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\(^9\) Such a system was used at Fairfield Plantation, c. 1730s, which is located in Charleston County about five miles east of McClellanville, South Carolina.
notched to restrain movement of the purlin. However, this type was rarely, if ever, used in colonial Charleston. A third form of connection is the butt purlin which is jointed to the principal rafter with a mortise-and-tenon joint. The butt purlin requires mortises to be cut out of the principal rafters. This loss of material leads to a weakness in the strength of the member at the point of maximum bending. Therefore, with a butt purlin additional strutting is often required to support the principal rafters. The type of purlin most commonly found in Charleston, South Carolina is the butt purlin.  

![Figure 3.8: Types of purlin Connections from left to right 1) Butt Purlin 2) Trenched Purlin 3) Clasped Purlin. (Drawings by author)](image)

In a principal rafter roof, the load is taken on by the principal rafters which then pass a portion of it onto the tie beams. The connection between the principal rafter and the tie beam is a critical one. In the earliest frame houses, the principal rafters were commonly tenoned and pegged to the tie beam. The proportion of the load transmitted depends on the relative stiffness of the principal rafters and the tie beam as well as the arrangements of the purlins and struts. The common rafters provide stability and rigidity to the structure, but

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the purlins carry the load for them. Thus, the common rafters became structurally superficial.\textsuperscript{11}

Wind bracing could be used to connect the purlins and the principal rafters. This framing technique had been largely abandoned in Britain at the time but remained common practice in areas of Virginia and Maryland through the end of the eighteenth century. Charleston appears to have subscribed to the British mentality that sheathing and clapboards provided enough protection against racking because no existing examples of wind bracing were found in this survey.\textsuperscript{12}

\textit{39 Church Street}

The George Eveleigh House is a double-pile plan that was constructed at 39 Church Street about 1743. The two-story brick house, built for a prosperous deerskin trader, features a large drawing room with a vaulted ceiling on the second floor.\textsuperscript{13} A principal rafter frame roof construction supports the gabled roof. Butt purlins carry the weight of the roof for the common rafters and transfer the load into the principal rafters.\textsuperscript{14} Collar ties are half lapped dovetailed to the principal rafters and secured with wooden pegs. The principal rafters and common rafters are mortised-and-tenoned together at the roof ridge and secured with wooden pegs. The vaulted ceiling of the second floor drawing room projects into the attic space. Curved wooden ceiling joists provide a curved surface to attach the plaster lath.

\textsuperscript{11} Yeomans, \textit{The Trussed Roof}, 19; Graham, "Timber Framing," 229.
\textsuperscript{12} Graham, "Timber Framing," 229.
\textsuperscript{13} Poston, \textit{Buildings of Charleston}, 216-217.
\textsuperscript{14} A site survey was not conducted at the George Eveleigh House. Information regarding the frame roof construction was derived from oral interviews with local contractor, Richard Marks, and from pictures provided by Glen Keyes of Glen Keyes Architects, who have worked at 39 Church Street.
Figure 3.9: A collar tie is dovetailed into the principal rafters at 39 Church Street. (Photograph provided by Glenn Keyes Architects, Charleston, SC)

Figure 3.10: Bent timbers provide the form of the vaulted ceiling and straight timber members support the weight of the vaulted plaster ceiling. (Photograph provided by Glenn Keyes Architects, Charleston, SC)
The M-Roof

The M-roof was employed for large building spans such as those structures with a double-pile plan. For large building spans, the roof framing methods were limited by the structural technologies available as well as the sizes of the timbers available. M-roofs were advantageous because they allowed for the use of lighter and shorter rafter pairs in comparison with the principal rafter roof. They were also cheaper to frame in comparison to other frame roof technologies and provided a more stylish, lower profile roof.\(^\text{15}\)

In double-pile plans, the main body of the house was typically divided by a central wall with rooms on either side. This allowed the floor timbers to be half the width of the overall building footprint. Each half of the building would then receive its own roof with a simple pitch. The two sets of frames led down to a central valley which served as an internal gutter. This drain was typically a lead-lined wooden trough that ran the length of the roof space and connected to external gutters. The weight of the roof was transferred to the central valley and carried to the partitions that divided the front and rear rooms of the double-pile house. In cross-section, the roof has an M-shaped appearance. The utilization of the M-roof allowed the span of a roof structure to be the width of one room.\(^\text{16}\)

This design was not without its faults. The M-roofs were notorious for leaking along the central valley. The M-roof relied on the success of a series of internal gutters. These gutters often clogged, cracked, or leaked. This malfunction often resulted in water damage to the interior of the building. The inefficiencies of the M-roof were soon recognized by carpenters and building owners, and were eventually replaced by trussed roofs.

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\(^{15}\) Graham, “Timber Framing,” 230.

\(^{16}\) Yeomans, The Trussed Roof, 20
In addition to the technical issues with M-roof construction, a change in aesthetic preference for roof geometry necessitated the replacement of M-roof forms. The most significant change in Charleston was the move towards roofs with hipped ends rather than gabled ends. The hipped roof posed unique challenges to the carpenters they had not otherwise been exposed to. If the span of the roof remained small enough, a hip roof could be combined with the familiar common rafter roof form. In some cases however, the attic space was dictated by specific uses limited the framing methods to principal rafter roofs with collar ties.

Perhaps the largest limitation to the M-roof design was the distance the roof could span. As new money poured into Charleston from the rice and indigo industries, the city demanded larger public buildings and churches for which traditional framing methods were inadequate. The introduction of the king-post truss solved the roofing problems the principal rafter and M-roofs could not.

Figure 3.11: A SketchUp model depicts the M-Roof at Fenwick Hall, dating to the third quarter of the eighteenth century. (Drawing by David Weirick and Lauren Golden)
Conclusion

Various forms of early eighteenth century traditional frame roof construction remained popular throughout the eighteenth and nineteenth century. The common rafter roof, capable of achieving building spans between twenty and twenty five feet, remained the popular choice for the roof construction of the Charleston “single house” plan. Prior to the development of the truss roof technology, the common framing type constructed for building spans of twenty five to thirty feet was the principal rafter roof. Occasionally, the principal rafter roof could accomplish a building span up to thirty five feet if internal bearing walls were used to provide additional support to the tie beam to prevent deflection. After the introduction of the truss roof technology, the principal rafter roof remained popular for larger “single house” plans as well as some double pile plans. However, as building spans increased and surpassed thirty feet they were often bypassed for truss technologies. Unlike the common rafter and principal rafter roofs which continued to be used to support building spans less than thirty feet, the M-roof was quickly replaced by trussed roof technologies.

Trussed roof technology came to the British colonies with the arrival of English architects and carpenters. Pattern books and trade manuals provided further disseminated trussed roof designs. An evolution in trussed roof design is evidenced by surviving eighteenth and nineteenth century Charleston buildings. The following chapters examine each trussed roof typology constructed in Charleston between 1740 and 1820. The history and structural behavior of each design is discussed and Charleston examples are provided.
CHAPTER FOUR

THE KING POST TRUSS

The emergence of the king post truss in Charleston reflected a confluence of economic and political factors, architectural taste, and the impact of natural disasters. By the 1740s profits from the booming rice industry, the desire to emulate British culture, and a devastating fire precipitated a new era of design in the building traditions of Charleston. These new designs represented a shift away from craft-based industries to designs motivated by science and technology. Craftsmen developed an understanding for the structural behavior of the new roof forms they were constructing and a sophisticated design emerged.

By the close of the 1730s, Charleston had long outgrown its origins as an impermanent settlement to become a fully developed, urbanized colonial city. Charleston was now the fourth most populous city in the British colonies but, more important, the city had arisen as the wealthiest colony in British America. Like in many colonial cities, Charleston's wealthiest citizens formed an elite class consisting of prominent planters and successful merchants. This wealth afforded the southern colonial city the opportunity to build a bigger and better city than many of Charleston's colonial counterparts. A convergence of factors solidified Charleston's position as the wealthiest British American city in the mid-eighteenth century, including numerous profitable agricultural industries and the expansion of trade routes.¹

The Fire of 1740 provided an opportunity to reconstruct much of the city. With a blend of local and English carpenters, assisted by slave labor, Charlestonians rebuilt the city with a variety of new structures.\(^2\) In the 1740s, Charlestonians were heavily influenced by the latest trends in England, including preference for shallow pitched roofs with either pedimented gable ends or hipped ends. Charleston increasingly replaced the traditional roof framing methods used for the earlier roof forms like the common rafter frame, the principal rafter frame, and the M-Roof frame with more complex trussed roof forms for many of their most impressive buildings.

In addition to the change in style, Charleston rebuilt on a larger scale with bigger, more grandiose buildings. The traditional framing methods used previously were incapable of accommodating building spans in excess of thirty feet. Therefore, craftsmen were faced with the challenge of developing new structural solutions to fit this growing need. Charleston turned to popular British forms for their roof framing problems. The most common type of roof framing adopted was the truss roof, which accommodated roof spans in excess of thirty feet with the use of king or queen post trusses. These trussed roof systems adopted by Charlestonians after 1740 differed from traditional frame roofs in the structural functions of the timber-framing members as well as in the construction details used to construct the roof assembly. The simplest form of these new truss roofs was the king post truss which could effectively support a roof for building spans up to forty five feet in length.\(^3\)

\(^2\) George C. Rogers, Jr., *Charleston in the Age of the Pinckneys* (Columbia, SC: University of South Carolina Press, 1980), 10-11.

The first known king post truss roof to be constructed in England was designed by Jones in 1619 for the Banqueting House in London, which had a building span of sixty feet. Although Jones was the first designer to construct a true truss roof in England, Christopher Wren is credited with popularizing the truss design. Wren developed the truss design further to create the queen post truss which allowed for usable attic space and flatter roof designs.4

The History of the King Post

The earliest documented use of the “modern” king post truss roofs in England can be found in the designs of Inigo Jones (1573-1652) and Christopher Wren (1632-1723) although Wren predominately used a form known as the queen post truss, which developed from the king post truss. Jones’ roof designs closely resembled truss roof designs published in Italian pattern books.

Research indicates English trussed roofs likely developed from Italian trussed roof designs which were constructed even earlier than those in England. Historians hypothesize that Jones may be responsible for bringing the trussed roof to England. Although Jones studied in England, he traveled through Italy where he probably saw examples of king and queen post roofs. Late sixteenth century pattern books by Andrea Palladio and Sebastiano Serlio illustrated variations of the king post truss roof form. The drawings of Palladio and Serlio provided enough information to allow architects like Jones to mimic the designs. In 1621 Bernardino Baldi produced a book on mechanics that attempted to describe the

behaviors of the king post truss. Baldi’s description of structural behavior was basic at best, but the joints between the principal rafters and the tie beams were shown in more detail than previous pattern books had depicted, further enabling architects to copy and construct the work of these Italian designers.\(^5\)

**Figure 4.1:** An illustration by Bernardino Baldi, c. 1620, depicts a king post truss connected to the tie beam with an iron strap. (Image from David Yeomans, *The Trussed Roof*, 31)

English truss roof designs are distinguished from other European truss roof designs by the use of “joggles”, which are splayed angles cuts placed at the base and head of the supporting posts to receive inclined struts. In Italy, France, and Germany, roofs with suspended king posts relied on members in compression being “let into the sides of the posts that they supported.” English carpenters, for reasons unknown, used joggled posts to accentuate the behavior of the structure. Although joggles clearly dictate the structural actions of the king post roof and its timber frame members, it requires the use of larger timbers. Furthermore, the cutting down of the timbers is more labor intensive than other European methods.

The king post truss allowed for the creation of lower roof pitches that were previously unattainable with traditional frame methods. The roof pitch was calculated by setting the height of the king post as some proportion of the building span. In 1733, Francis Price published instructions for construction of one of three different pitches using king post truss roofs. Price’s recommendations corresponded with the type of material used for the roof covering, which included lead, pantile, or slate roofs with a pitch of 45°, 26½°, and 37° respectively. Although Price wrote about the king post truss in 1733, it was Peter Nicholson’s publication, *The Carpenter’s New Guide*, in 1792 that finally shed light on the

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6 For further information refer to the illustrated glossary included Appendix A of this study.
structural behavior of the truss in qualitative terms. Nicholson described a more complex truss system than the simple king post truss forms found in Charleston. Nonetheless, his description marked a turning point in roof carpentry from a craft-based industry to one based on engineered solutions and technology.\(^9\)

\[\text{Figure 4.2: Drawings by Francis Price illustrate the construction of three different roof pitches using variations of the king post trussed roof. (Francis Price, The Carpenter's New Guide, 1792)}\]

\(^9\) Yeomans, The Repair of Historic Timber Structures, 36-41.
Structural Composition of the King Post

In traditional frame roofs the support typically comes from the rafter pairs which push against each other and against the wall plates to act in compression. In a king post truss roof, the central king post provides structural support to the tie beam. This critical structural post acts in tension, thus distinguishing the king post truss from other traditional frame roofs. The king post becomes the primary supporting member and has a diamond-shaped head at the top of the post. This widened head is held between the principal rafters at the ridge of the roof, thereby suspending the king post. The base of the king post typically joins to the top of the tie beam. Often, wrought iron U-straps loop under the tie beam and connect to either side of the king post. In king post trussed roofs of any great size, the iron strap is imperative to the success of the trussing action.\(^\text{10}\)

\[\text{Figure 4.3: Free Body Diagram depicts members in compression and members in tension. (Drawing by author)}\]

The difference between traditional framing methods and truss roof systems like the king post truss are often muddied by conflicting nomenclature. Earlier roof forms are commonly referred to as truss roofs even though there is no trussing action present. The implementation of a construction detail known as a joggle transforms the roof frame from a triangular frame to a true truss roof because it allows the truss to attach to the principal rafters at the apex of the roof. This changes the truss condition from compression to tension in the supporting posts. The angle of the joggle at the head of the king post was cut to match the angle of the principal rafters. The ends of the principal rafters were then fixed to the joggle in a variety of ways. A mortise-and-tenon joint with a single peg was the most common method used to fix the principal rafter to the king post. The base of the king post was also enlarged and featured juggles to receive struts. The struts were typically connected with mortise-and-tenon joints, each single pegged into the juggles of the king post, and ran up to the center of the principal rafters. The joint between the strut and the principal rafter was commonly mortised-and-tenoned, but nailed connections have also been found in Charleston. Any bending inflicted on the principal rafters by the purlins would place the struts in compression. The struts would then push down on the juggles, which would cause the king post to pull down on the principal rafters. The struts also helped to prevent deflection in the rafters under the weight of the roof. Occasionally, additional posts and struts were added to the king post truss roofs to provide additional support or to assist in the creation of the overall roof form.  

Figure 4.4: A king post truss design illustrated by Owen Biddle, 1805. (*Biddle’s Young Carpenter's Assistant*, Plate 24)

In most cases, a tie beam was located directly below the king post. The post was connected to the tie beam with a mortise-and-tenon joint. The joint was often further secured with the use of a wrought iron U-shaped strap that passed below the tie beam and fixed to the base of the king post on both sides. In cases where the tie beam was wider than the base of the king post, the English solution was to thread the metal strap through slots in the tie beam. In Charleston, the tie beam is chiseled out around the U-strap (Figure 4.6). One or two metal bolts were used to fasten the strap to the king post. The king post was therefore placed in tension between the rafters and the tie beam and effectively held up the tie beam. The introduction of the king post truss allowed the roofs to be spanned with smaller tie beams whose only job now was to resist the outward thrust the principal rafters exerted on the exterior walls and to counteract the bending loads placed on the rafters from the weight of the ceiling.¹²

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The development of the trussed roof enabled the tie beam to be made out of several timbers scarfed together. In England, the joint between two tie beam halves was first made with a splayed, table scarf joint that would be tightened with a wedge driven into the center of the joint. Iron bolts were another method used for holding two timbers together in a manner that would allow the transfer of tensile forces. A third method of connection involved the placement of iron straps across the joint between the two halves of the tie beam. These seventeenth and early eighteenth century methods were replaced in the late eighteenth century with the simpler method of placing the tie beam scarf joints side-by-side and fastening them together with iron bolts.\textsuperscript{13}

The drawback to a truss design that used principal rafters to support the king post was the distribution of a much larger outward force placed on the tie beam from the principal rafters. The joint between the foot of the rafters and the tie beam became more critical than ever before as it had to effectively restrain the tendency of the rafters to thrust outward. The joint used most often in traditional roof frames was a mortise-and-tenon joint

\textsuperscript{13} Yeomans, \textit{The Trussed Roof}, 26.
in which the outward thrust would be resisted by the short vertical face of the tenon. As building spans increased and the roof pitch was reduced, the forces on the joint were increased and the mortise-and-tenon joint was no longer a sufficient form of connection. In Charleston as well as England, metal strapping and iron bolts were introduced to assist the mortise-and-tenon joints in restraining the outward movement of the principal rafters.14

Some English king post roofs were commonly built with closely spaced purlins between the principal rafters in lieu of common rafters. This system was quickly deemed inadequate in England and many closely spaced purlin roofs were replaced with common rafters and large purlins. This second design solution is the structural solution that emerged in the southern colonies in the eighteenth century, while multiple purlins held resonances in New England for different reasons.

Roof systems that utilized large horizontal purlins typically used mortise-and-tenon connections or, alternatively, tusked tenon joints between the principal rafters and the purlins. This was simplified in the nineteenth century to a design in which the purlins were carried on the backs of the principal rafters. In the latter design, a timber block was fixed to the back of the principal rafter below the purlin to hold them in position. Nicholson’s design shows trenched purlins that prevented the common rafters from connecting to the wall plate and therefore, an additional member known as a “false plate” was required. This false plate would run across the top of the tie beam to provide a connection point for the ends of the common rafters. At the apex, the common rafters could be butted and nailed to a ridge board, or as seems common in Charleston, mortised-and-tenoned together in the style common to older traditional roofs.15

The king post truss was used to accommodate a wide array of building spans and uses. The carpentry details could often be revised or changed by individual carpenters with little effect on the structural capacity of the roof framing system. Although the king post truss frame was advantageous in many ways, it could not meet the demands of increasing building spans of the late eighteenth and nineteenth century. Additional support in the way of secondary posts and struts became necessary as building spans increased to provide assistance to the tie beam and to provide the principal rafters with the capability of carrying two sets of purlins.16

**Variations on the King Post Truss**

The most basic king post truss roof design could comfortably support a span of thirty to thirty five feet. As spans approached forty five feet, additional supports were required to assist the king post in preventing deflection in the tie beam and the principal rafters. By the end of the eighteenth century, Charleston saw the construction of large buildings whose spans exceeded forty feet. This was especially the case for church buildings because the addition of secondary supporting posts eliminated the need for load bearing support walls below, thus enabling the construction of undivided interior spaces below the tie beam. Reinforcement of the simple king post truss through the addition of supporting members allowed architects and craftsmen to continue construction roof frames in a now familiar method.

The greatest structural challenge for the king post truss roof in buildings with a span greater than thirty five feet was the effective prevention of deflection of the tie beam. As spans approached forty feet, it became cumbersome to manage a single-length timber to serve as the tie beam. Therefore, two or more timber pieces were often joined together,

typically with a scarf joint. This joint rendered the tie beam incapable of resisting bending without additional supports. To prevent deflection of the tie beam, a pair of secondary posts was installed. Much like the king posts, these secondary posts were suspended from the principal rafters at the top and connected to the tie beam at the base with a mortise-and-tenon joint and iron U-straps secured with bolts.

The structural operation of the king post truss with secondary posts is very similar to that of the simple king post truss. In this variation, the king post remains positioned at mid-span, suspended from the principal rafters at the apex of the roof and connected to the tie beam with a mortised-and-tenoned joint and secured with an iron U-strap. The king post remains in tension, preventing deflection in the center of the tie beam. The addition of secondary posts is often required when the tie beam is made up of several pieces scarfed together either in two halves, or in thirds. The secondary posts are placed on either side of the king post, effectively dividing the tie beam into thirds. These posts are fixed to the tie beam in the same manner as the king post with a mortised-and-tenoned connection and metal strapping at the base to secure the post to the tie beam. The posts are mortised-and-tenoned into the principal rafters and secured with either one or two pegs. These posts also act in tension which provides additional “trussing” of the tie beam. The base of each secondary post contains a joggle on one side to receive a strut which connects to the principal rafters and provides additional resistance against bending.\textsuperscript{17} Struts connected to the joggles on the base of the king post are received by the secondary posts. These struts provide stability to the system and prevent deflection in the secondary posts.

\textsuperscript{17} Yeomans, \textit{The Truss Roof}, 38-44.
Figure 4.6: A drawing by Peter Nicholson illustrates the difference between a simple king post truss and a king post truss with secondary posts. (Yeomans, *The Repair of Historic Timber Structures*)

**The Charleston King Post**

Architects and carpenters in Charleston employed the simple king post truss as one solution to span greater distances and to support the larger and more complex roof forms that inevitably come with larger buildings. The simple king post first appears in Charleston in the mid-eighteenth century and continued to be used into the first quarter of the nineteenth century.

**Blake Tenements**

The earliest known king post truss to be used in Charleston was found at the Blake Tenements at 4 Courthouse Square in Charleston, SC. Constructed between 1760 and 1762, this double tenement house measures 43'-4½" x 48'-7". The tenement is a masonry building
with two brick chimneys protruding through the hipped roof at either end. The roof is currently covered with slate tiles.\textsuperscript{18}

Two king posts, spaced 4'-0" apart support the tie beams which each measure 9 ¾" wide by 10" tall. Hip rafters tie into the top of each king post, while principal rafters tenon into upper joggles at an angle of thirty degrees. The primary difference between Baldi’s design and that of Blake Tenements is the use of “struts” between the tie beam and the principal rafters. These braces are mortised-and-tenoned into the tie beam and secured with two pegs in a common connection form. Unique to this property is the connection between the brace and the principal rafter which features a mortised-and-tenoned joint that is secured with three pegs. Common rafters spaced 2'-0" on center span between each pair of principal rafters. Continuous purlins span over the front of the common rafters and tenon into the principal rafters.

Figure 4.7: A section cut through the attic at Blake Tenements illustrates a king post trussed roof with inclined struts and knee braces. (Drawing by author)
Each king post measures 1'-1" x 7 ¾" at the base below the joggles. The post above the joggle measures 7 ¾" square with no taper present in the member. The king post truss is fixed to the tie beam with a wrought iron U-strap. Wood shims are wedged between the U-strap and the king post base, indicating that the U-strap was too wide for the king post. It is more likely that the builder was not familiar with the English method of threading the U-strap through the tie beam when the tie was wider than the base of the truss. The strap is fixed to the wood shims and the king post with metal bolts. A finished floor prevents inspection of the tie beam to verify if it is wider than the king post. It is also unclear whether the tie beam is one timber or two timbers scarfed together. Given the span of the building, it is very likely that a scarf joint was used to assemble the tie beam, but the type of joint is unknown.

*Figure 4.8:* The base of the king post is strapped to the tie beam with a wrought-iron U-strap in Blake Tenements. (Photograph by author)
Perhaps the most curious member in the Blake Tenement roof is the timber frame member located between the two king posts approximately 12” below the ridge of the roof. The timber measures 12” x 12” and sits on wood ledgers nailed into the king post. Score marks that align with the location of the common rafters are present, indicating that this piece may have served as a layout marker for the builders assembling the roof. This dropped ridge could also have acted as a stabilizing member to hold the two king posts upright until the rafters and sheathing were installed. A similar system has been noted in several other Charleston buildings as well as houses built in Beaufort, South Carolina.19

Figure 4.9: A dropped ridge board spans between the king posts approximately 12 inches below the roof ridge. (Photograph by author)

19 Dropped ridgeboards like the one found at the Blake Tenements have also been found in Beaufort, South Carolina through research conducted by Carl Lounsbury, Willie Graham, and Jeff Klee of the Architectural Research Department at the Colonial Williamsburg Foundation. This suggests the dropped ridge board may be a regional construction detail.
The principal rafters, hip rafters, king posts and struts are pit sawn on three sides and hand planed on the primary face to allow for more precise joinery. The common rafters and purlins were made from stock pit sawn and hewn counts. A partition wall made of pit sawn boards divides the attic space in half. This is an indication that the area served as usable storage space. The builders clearly wished to provide a finished face to the members that would be most visible to the attic occupants. The planed surfaces in Blake Tenements were indicative of a more labor intensive, and therefore more costly, method of finishing timbers.

Twenty four existing properties were identified as tenement houses in Charleston between 1740 and 1820 with building spans greater than twenty-five feet. The building spans of this sample pool ranged from twenty-six feet to fifty-five feet. The king post truss system used to construct the Blake Tenements represents a typical engineering solution to the double tenement house with building spans up to about forty feet. For triple tenements, spans approaching fifty feet or greater necessitated more complex truss systems. These structural solutions will be discussed in the next chapter.

_**St. Philip’s Parsonage House**_

St. Philip’s Parsonage House, also known as Bishop Robert Smith House, was constructed about 1770 at 6 Glebe Street. The structure is laid out as a double-house and measures 44’-7” x 48’-6”. The data collected for 6 Glebe Street was limited to the information supplied by drawings and photographs from Historic American Buildings Survey (HABS) records. Robert A. Busser completed measured drawings for HABS as part of the South Carolina Lowcountry Project in 1963. Although Busser’s drawing indicates the
use of a king post truss, the roof framing is partially documented on the measured drawings.\textsuperscript{20}

From the section cut drawn by Busser, it can be determined that the double-pile span of the St. Philip's Parsonage House was achieved through the use of a king post truss. The king post constructed here closely resembles the design illustrated by Peter Nicholson in 1792 in which the king post connected to secondary posts with struts. The difference between Nicholson's design and 6 Glebe Street is the absence of a second pair of struts spanning between the secondary posts and the principal rafters in the Charleston design. In lieu of a second pair of struts, St. Philip's Parsonage House has angled braces compressed between the tie beam and the principal rafters. Busser did not indicate the types of connections used for the braced members.

The height of the king post at 11'-6" creates a roof pitch of 25.7\textdegree. From the information provided by the HABS drawings, it may be inferred that the design for this roof was influenced by Price's design for a 26.5\textdegree pitch. If the margin of error for the measurements of the building width and attic height are off by 3.6" then a slope of 26.5\textdegree would be achieved. This hypothesis is further supported by the similarity in the appearance and structural function of the two roof designs. Although St. Philip's Parsonage House lacks the second pair of struts, Price illustrates braces are added to provide additional support to prevent deflection of the principal rafters just as the secondary struts accomplish in the 1733 design.

\textsuperscript{20} Poston, \textit{The Buildings of Charleston}, 524-525.
Figure 4.10: A partial section cut of 6 Glebe Street indicates a king post truss roof design is used to support the roof of the masonry residence. (Image taken from a full section cut drawn by Robert A. Busser, *Historic American Buildings Survey* (HABS) collection, www.loc.gov)

Unfortunately, without direct access to the building, many questions are left unanswered. Joinery and finishes are not specified in the measured drawings provided by HABS. Without this information it is impossible to know if this was the original truss design, or if additional supports were installed retroactively to provide necessary support to a failing structural system. The types of connections used are crucial to understanding whether the timber frame members are in compression or tension. The section cut provided as part of the HABS drawings shows two partition walls on the third floor directly below the attic level. These partition walls do not align with the king post or secondary posts, which suggests a necessity for the king post to “truss up” the tie beam at the vulnerable mid-point.
**Heyward-Washington House**

The Heyward-Washington House, located at 87 Church Street, was constructed in 1771. This three-story masonry double house measures 42’-5” x 45’-6”.

The roof structure consists of two king posts measuring 6 ¾” x 6 ¾” spaced 6’-8” apart. The top joggle of each post receives two principal rafters and the exterior faces receive the hip rafters. The king posts are made of pine and have a combination of adzed and hand planed surfaces.

![Two king post truss frames support the tie beams at the Heyward Washington House. (Photograph by author)](image)

**Figure 4.11:** Two king post truss frames support the tie beams at the Heyward Washington House. (Photograph by author)

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The principal rafters each measure 6 ¾" x 9" at the foot and taper to 6 ¾" x 7 ¾" at the apex of the roof. The rafters are hewn on three sides. The face of the principal rafters that faces inwards is hand planed on the top two thirds and adzed on the lower third. Each rafter is mortised-and-tenoned into the top joggle of the king post and fixed with a single peg. Adzed and pit sawn purlins are tenoned through the principal rafters and secured with a single peg. The staggered purlin rows are set flush against the bottom of the principal rafters.

The common rafters measure 3 ½" x 3 ¾" and are spaced 1’-5" on center except where the two masonry chimneys protrude through the attic space. Unlike the principal rafters, the common rafters do not taper. The common rafters used to construct the roof hip are butted and nailed to the hip rafters, while the common rafters used between the principal rafters are mortised-and-tenoned with a single peg. The feet of the rafters are butted and nailed to a false plate that sits on top of the masonry walls.

A dropped ridge board is located approximately 12" from the apex of the roof between the two king posts in the Heyward-Washington house, just like the dropped ridge board in the Blake Tenements. This member measures 3 ¼" x 3 ¾” and sits on wood ledgers that are nailed to the king post with wrought iron nails. Score marks are evident on the dropped ridge which aligns with the placement of the common rafters.
Figure 4.12: The feet of the common rafters are butted and nailed to a false plate that sits on top of the outrigger joists at the Heyward Washington House. (Photograph by author)

The size, spacing, and finishes of these features might suggest a typical king post truss design, but the Heyward-Washington House roof is anything but typical. The anomaly is instantly visible upon examination of the flooring framing system. Two tie beams measuring 8” x 8 ½” span the width of the building. Floor joists measuring 3” x 7 ¾” on average connect to the tie beam at ninety degree angles with mortise-and-tenon joints. The joint connections are secured with a wood wedge. The joists are spaced 1’-8” on center. The top face of the joists are hand planed while the sides of the joists show a combination of hewing and pit sawing techniques. Roman numerals are carved into the top face of the joists and align with the matching Roman numerals carved into the top face of the tie beam.
The abnormality in this design is found in the location of the king post in relation to the tie beam. In typical truss designs the king post sits on top of the tie beam and pulls up on the tie beam to prevent deflection. In the Heyward-Washington House the king post sits on top of a truncated tie beam that measures 5 ½" wide by 7 ½" deep and 1’-7" in length. The base of the king post is strapped to this short tie beam with a wrought-iron U-strap and secured with iron bolts. The truncated tie is set 6" inside the tie beam and joins into girders located on either end through a mortise-and-tenon connection and secured with a wood wedge. The girders used to stabilize the truncated tie beam are 3 ¾" wide x 8" deep and run between the two tie beams in parallel with the floor joists. The girders are mortise-and-tenoned into the tie beam at either end and secured with a single peg. Why carpenters chose to build such a strange system remains a mystery.

A 3 ¾” x 7” perimeter plate is located 3’-6” from the outer foot of the rafters. Outrigger joists measuring 3” x 7” connect at a ninety degree angle to the perimeter plate with a wedged mortise-and-tenon joint. These outriggers are spaced 1’-9” on center except where girders are located to support the feet of the principal rafters. Where the principal rafters meet the wall plate, 3 ¾” x 9” girders span between the wall and the perimeter plate. The principal rafters are mortised-and-tenoned into the girders and secured with a single peg. A wrought iron U-strap runs underneath the girder and connects to the sides of the principal rafter with metal bolts, further strengthening the connection between the two members.

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22 In a few locations, iron wedges were used in place of wood wedges.
The structural composition of this king post trussed roof is radically different from those at the Blake Tenements or St. Philip’s Parsonage. It is difficult to understand how the king post can effectively “truss up” the tie beam in this layout, or how the girders connected to the perimeter plate can support the load transmitted through the feet of the principal rafters. Several campaigns of metal reinforcements are visible at the feet of the principal rafters, indicating that perhaps this design was, in fact, ineffective at achieving the desired results.

Perhaps the carpenters responsible for the construction of the king post truss were familiar with current design trends but did not fully understand structural forces. There is a clear intention to construct a king post truss, but the alignment of principal members such as the principal rafters, the king post, and the tie beam indicate a lack of understanding with
regards to how the system works together to support the tie beam. All known trussed roof buildings constructed after 1771 utilize the more complex queen post truss or more sophisticated variations of a truss roof like the raised tie beam truss.

**Conclusion**

King post truss systems were adopted to accommodate the large building spans that simpler traditional frames could not. Charlestonian’s desire to build ever larger churches, public buildings, and double-pile house plans necessitated the implementation of the king post truss years after English craftsmen had adopted the basic truss form. Design books like Moxon’s *Mechanick Exercises*, and pattern books by Nicholson, Price and Palladio guided the design of the king posts constructed in Charleston, but it is likely that carpenters had a greater influence on the final design of the roof. The data collected through site surveys reveals that each Charleston king post truss has unique details. Whether these eccentricities were found in the layout, finishing techniques, or joinery methods, the differences indicate that the carpenters were likely entrusted with the decisions regarding dimensions and style.
The queen post truss design developed from the simpler king post truss design. This more sophisticated truss was adopted in Charleston because the size and layout of the newly constructed late eighteenth century residential buildings created a need for additional space, often to provide living quarters for the residents or for house staff. The existing king post truss methods prevented utilization of the attic space in large residential houses. Spatially, the placement of the king post divided the attic in half and had cumbersome struts that prevented it from being used as a garret. The queen post truss design created unencumbered space because it placed posts towards the outer edges of the building, thus creating an open area through the center of the attic for additional living space.1

The queen post truss could effectively support building spans up to sixty feet whereas the king post truss was limited to spans of about forty five feet. From the queen post truss developed the king-and-queen post truss combination. This complex queen post truss design provided the spatial benefits of the queen post truss and was structurally capable of supporting a building span as large as seventy feet.2

**History of the Queen-Post Truss**

The history and development of the queen-post truss is less clear than that of the king post. Much like the king post truss, the origins of queen post truss can be traced back to Italy through illustrations by Palladio and Serlio. In Britain, Christopher Wren popularized

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2 Yeomans, *The Trussed Roof*, 60.
the queen post with his extensive use of the design in churches and prominent public buildings. Historian David Yeomans hypothesizes that although Italian designers like Palladio illustrated queen post truss designs, Christopher Wren's designs differ in a manner that indicates he likely developed his queen post design independent of Italian influences. Wren's queen post trusses are associated with flat top roofs with steeply-sloping sides. In contrast to Wren's design, Palladio's queen post truss was used with simple pitched roofs.\(^3\)

The queen post truss members commonly found in Charleston most closely resembles Wren's designs but the roof forms are more closely akin to the simple pitched roofs of Palladio's designs. Although English carpenter's manuals, like Francis Price's *The British Carpenter* and Batty Langley's *The Builders Jewel* from the early eighteenth century illustrate queen trusses, they did not become popular until the second half of the eighteenth century. In Charleston, the earliest queen post truss dates to the construction of St. Michael's Church in 1751 where two queen posts were used in conjunction with a king post truss. Despite the known existence of this technology, the queen post does not appear to have gained wide use popularity until the turn of the nineteenth century.\(^4\)

In the nineteenth century the application of the queen post expanded beyond large, pretentious structures to architecturally simple buildings. The popularity of the queen post truss design can be attributed to several structural and functional factors. Structurally, the queen post truss was superior to the simple king post truss because it provided two points of support to the tie beam, rather than one. Furthermore, a queen post truss with supporting struts carried two pairs of purlins which strengthened the principal rafters against deflection from the roof load. The efficiency of queen post truss construction was

\(^3\) Yeomans, *The Trussed Roof*, 106-110.

greater than that of the king post because the design required shorter lengths of timbers for
the posts. These shorter truss posts could achieve the same building span as the longer king
post. In addition, the queen post truss created more habitable attic space than the king post
truss.\(^5\) The queen post truss eventually became the preferred method because it provided
the craftsmen with the flexibility of choosing a wide variety of roof profiles with reduced
overall roof heights and additional attic space. Why the queen post truss design was
abandoned in Charleston for nearly half a century after the construction of St. Michael’s
Church remains a mystery.\(^6\)

In addition to steeply pitched flat topped roofs, queen post trusses served as an
early framing method for the construction of domes. Queen posts are particularly well
suited for dome construction because two sets of queen post trusses provide four points
through which the weight of a plaster ceiling can be distributed. Furthermore, the use of the
queen post truss prevents the need for radial trusses whose tie beams would have
intersected one another causing one post to support the majority of the load. The king post
truss design was ill-suited for dome construction because the singular post required these
radial trusses, as well as the additional support of struts.\(^7\)

**Structural Composition of the Queen Post Truss**

The queen post truss effectively spanned greater distances than the king post truss
roof or traditional frame roofs. Although the queen post truss could support a span of sixty
feet or greater, timbers were not readily available in the lengths required for the tie beams.
To accommodate the longer spans, a tie beam could be comprised of two or more members

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7 Yeomans, *The Truss Roof*, 125.
joined together with a scarf joint. This connection point inherently weakened the overall strength of the tie beam, and therefore additional support locations were imperative to the structural success of the roof frame. The queen post truss was preferred for scarfed tie beams because the design provided two points of support, compared with the one support location provided by the king post truss. The basic queen post truss roof design is comprised of six members: the tie beam, a pair of principal rafters, a pair of queen post supports, and a collar tie.

![Figure 5.1](image)

**Figure 5.1:** A free body diagram illustrated the loading conditions of each member in a queen post truss. (Drawing by author)

In *The British Carpenter*, Price describes two queen post truss framing methods. In one such method, the tops of the queen posts tenoned into the short principal rafters strutting below the joggle. Another long continuous principal rafter laid on top of the short
principals above the queen post joggle to carry the purlins. In this framing technique the queen post was commonly tenoned into the short principal. In cases where the queen post was tenoned into the long principal rafter the connection simply secured the queen post location, rather than transmitting load between the members. In his second design, Price abandoned the combination of long and short principal rafters for one long principal rafter placed above the queen post joggle. With this roof form, a mortised-and-tenoned connection between the queen post and the long principal carried loads between the two members. In England, the more common arrangement was to have shorter principal rafters used as struts below the joggle at the head of the queen post. In Charleston, though, longer principal rafters predominated in queen post truss roofs. The same basic roof framing method was used with queen post trusses that formed flat topped roofs, except the queen posts were carried higher in order to support the ends of the principal rafters.

In a queen post truss design one strut was provided for each queen post that extended from the joggle on the base of the post to the principal rafter. The strut was commonly tenoned into the principal rafter halfway between the base of the rafter and the connection with the queen post. As with the king post, the struts provided resistance against deflection in the principal rafter and helped to stabilize the base of the queen post. English practice usually depended on joggles to support struts rather than having the struts tenoned into the sides of the posts. Charleston queen post truss roofs mirrored English

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8 Yeomans, *The Truss Roof*, 125.
10 Yeomans, *The Truss Roof*, 120.
fashion with joggles on one side of the base of the queen post to receive the struts. A collar tie typically spanned between the two queen posts to provide rigidity to the roof frame.¹²

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**Figure 5.2:** Queen post truss variations illustrated by Francis Price in *The British Carpenter*, 1733. Source: Image from Yeomans, *Repair of Historic Timber Structures*.

The Charleston Queen Post Truss

*South Carolina Statehouse/ Charleston County Courthouse*

The Charleston County Courthouse, constructed in 1753 as the South Carolina Statehouse at the intersection of Broad Street and Meeting Streets, has undergone numerous renovations and expansions over its lifespan. In 1792, a new courthouse was built in the same location, using the walls of the original two-story structure which was destroyed in the fire of 1788. Several renovations and additions resulted in a three-story stucco structure that measures 104'-0" long by 51'-0" wide. Fortunately, despite the addition of modern steel trusses to supplement the historic timber framed truss roof, the 1792 roof framing remains in place.¹³

To achieve a thirty two degree roof pitch for the Courthouse, the hipped roof is supported by six queen post truss frames spaced 8'-0" apart. For each truss frame, a tie beam measuring 8 ½" wide by 10" in depth is supported by two queen posts spaced 10'-11 ½" apart. Each queen post measures approximately 8 ½" x 10" above the base and rises 8'-0" to the collar tie. The splayed top of each queen post is mortised-and-tenoned into the principal rafter and secured with two pegs. The base of each queen post is mortised-and-tenoned into the tie beam and secured with two pegs. Wrought iron U- straps further secure the connection between the tie beam and the queen posts. The metal straps are secured to the base of the queen post joggle on either side of the post with iron bolts.

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¹³ Carl Lounsbury, *From Statehouse to Courthouse: An Architectural History of South Carolina’s Colonial Capitol and Charleston County Courthouse* (Columbia, University of South Carolina Press, 2001), 1-5.
The queen post truss roof of the Courthouse features long principal rafters that span the distance from the wall plate to the apex of the roof. Each principal rafter measures $8\frac{1}{2}''$ x $10''$ on average. The feet of the principal rafters are mortised-and-tenoned into the tie beam and secured with iron strapping. The principal rafters are mortised-and-tenoned together at the apex $7' - 8''$ above the top of the collar tie. Common rafters are uniformly spaced between the principal rafters and measure between $3''$ and $3 \frac{3}{4}''$ wide and $5 \frac{3}{4}''$ deep. The spacing of the common rafters ranges between $1' - 5 \frac{3}{4}''$ and $1' - 7 \frac{1}{2}''$ on center. The
feet of the common rafters are butted and nailed to a false plate. At the ridge, the common rafters are mortised-and-tenoned together and secured with a single peg. At the hipped ends, the angled rafters measure 5½” x 10”.

Figure 5.4: The common rafters are intersected by the hip rafter. Purlins run over top of the common rafters and tenon into the hip rafter in the Courthouse. (Photograph by author)

The feet of the hip rafters are mortised-and-tenoned into short girders, which are through-tenoned into a dragon beam and secured with a wedge. Two girders, each measuring 8 ½”x10”, run perpendicular to the tie beams between each truss set to provide rigidity to the floor system. These girders are mortised-and-tenoned into the tie beam and secured with a single peg. The floor joists run perpendicular to the tie beam and measure

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14 The original false plate has been replaced with a modern false plate in many locations. The modern false plate sits on a ledge that has been cut out of the original joists. It is unclear whether this cut was made to install the modern false plate, or if the cut was part of the original false plate connection. Modern steel straps loop around the back of the common rafters and under the floor joist to strengthen the connection between the rafters and the joists.
between 2 ½” and 3” wide. The joists are spaced 1’-4” on center and join to the tie beam with a mortised-and-tenoned connection that is secured with a single peg.

Two sets of staggered purlins span the distance between each truss to support the weight of the common rafters and redistribute the roof load to the principal rafters. The lower purlins are through-tenoned into the principal rafters and measure 6”x 10”. The upper purlins measure 5 ¾”x 9 ½” and are connected to the principal rafters with a mortised-and-tenoned joint. This joint is secured with a single peg.

Each queen post features a 1’-2” wide base with a joggle cut into the exterior-facing side of the post. A 5 ¾” x 8 ½” strut extends from the joggle of each queen post to the principal where it is mortised-and-tenoned and secured with a single peg to the rafter. A collar tie spans the width between the two queen posts. At each end the collar tie is mortised-and-tenoned into the queen posts and secured with a single peg. Unique to this roof form is the addition of two diagonal struts above the collar tie that provide support to the upper third of the principal rafters. These struts, 5’-5” in length, measure 6 ¼” x 8 ½”. Each strut is mortised-and-tenoned into the principal rafter and secured with a peg.
Figure 5.5: A section cut through the attic space of the Courthouse reveals a queen post truss roof. (Drawing by author)
History of the King-and-Queen Post Truss Combination

In addition to large spans, queen post trusses were also used to frame steeply pitched roofs. As the roof pitch increased, so did the length of the principal rafters, thereby requiring the use of more than one pair of purlins to prevent bending in the rafters. A shift in design aesthetic merited a change in pitch design from thirty degrees to forty five degrees. This change in pitch served as the catalyst for a change in framing technology which resulted in the adoption of the king-and-queen post truss combination. In a forty five degree roof, up to three sets of purlins could be required to support the weight of the roof. It was difficult to support purlins high on the principal rafters in a steeply pitched roof using existing king post truss technology. Price illustrated a less than ideal adaptation of the king post truss to support a roof pitch of forty five degrees in which inclined struts were replaced with a horizontal strut placed between the king post and the principal rafters above the upper purlins.\(^\text{15}\)

The king-and-queen post combination truss solved the structural issues which derived from the necessity for additional sets of purlins in a roof system. A third set of purlins increased the load placed on the principal rafters thereby increasing the risk of bending in the principals. The queen posts provided two points of strutting to support the principal rafters and the addition of a king post truss above the collar tie in a queen post truss created a location for a third support. Price illustrated the combination truss in *The British Carpenter*, in 1733.\(^\text{16}\)

Although king-and-queen post truss roofs were popular in Italy, the popularity of this truss style developed slowing in England and the British colonies. Yeomans

\(^{15}\)The adoption of a 60° pitch for Gothic Revival cathedral roofs in England further necessitated a shift away from king post truss forms to more complex framing technologies.

\(^{16}\)Yeomans, *The Truss Roof*, 109, 123-124.
hypothesizes that the queen post truss likely developed from the search to economize roof framing. The queen post and king-and-queen post trusses have advantages because they require shorter timbers for the principal rafters and lighter timber for the tie beam. Although recognition of the economic advantages of the queen post truss by builders was slow, the truss design would become a popular framing technique in England by the end of the eighteenth century. In Charleston, the king-and-queen post truss combination became popular in the first quarter of the nineteenth century.¹⁷

**Structural Composition of the King-and-Queen Post Truss Combination**

A common adaptation of the simple queen post truss roof form was the king-and-queen post combination which could be used to form a pitched roof with a simple ridge. In this design, a basic queen post truss design is implemented with the addition of a king post that stands on the collar tie to help form the ridge of the roof. The addition of the king post allowed the king-and-queen post truss to provide additional trussing action to the tie beam. This additional post could easily be arranged to assist the tie, either by suspending it from the collar tie using metal straps or by strutting it from the feet of the queen post.¹⁸ In this design, the collar tie acts as the tie beam for the king post truss above it.¹⁹

**The Charleston King-and-Queen Post Truss Combination**

*St. Michael's Church*

The construction of St. Michael’s church began in 1751 under the supervision of the project carpenter, Samuel Cardy, an Irish immigrant who had recently arrived in Charles

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¹⁸ Yeomans, *The Trussed Roof*, 119-120.
¹⁹ English truss roof design occasionally contains two separate horizontal members above the queen post for which the king post stands on. One member acts as a tie beam for the king post while the other serves as a collar tie for the queen posts. No examples of this roof form have been found in Charleston. Yeomans, *The Repair of Historic Timbers*, 43.
Towne. The exterior of the building, with the exception of the portico, was completed by 1756 and the entire structure was completed and opened for service in 1762.\footnote{Poston, \textit{Buildings of Charleston}, 184-185.} St. Michael’s is located on the prominent city intersection of Broad Street and Meeting Street and measures 59’-9 ½” wide by 105’-5 ½” long. St. Michael’s church features a gabled roof with flared eaves which is framed by six sets of king-and-queen post trusses.\footnote{The western most king-and-queen post truss set is a modern addition. The remaining five king-and-queen post truss show evidence that they are original to the church.} Each queen post is mortised-and-tenoned into a tie beam measuring 7 ¾”x 11¼”.\footnote{Modern steel plates obscured the base of the connection between the base of the queen post and the tie beam. While a mortise-and-tenon connection is visible from the side, it is unclear to see if there is metal strapping in place. Design precedents suggest metal strapping likely joins the tie beam to the queen post.} The queen posts measure 8 ¼”x 8 ½” and rise 8’-8” above the tie beam to the principal rafter where the members are connected with a mortise-and-tenon joint. A wrought iron U-strap loops above the top of the principal rafter and connects to the sides of the queen post and a metal bolt secures the connection. Struts measuring 6 ½”x 6” extend from the joggle on the base of the queen post to the principal rafter.

A collar tie is notched into the queen posts 7’-3” above the tie beam. The adzed collar tie is mortised-and-tenoned into the queen post and secured with a single peg. This framing member acts as the tie beam for the king post that stands on top of it. The king post is mortised-and-tenoned into the collar tie and secured with two pegs and a wrought iron U-strap. Struts extend from the joggles on the base of the king post to the principal rafters on either side of the king post, providing a third point of support to the rafters.
Three sets of purlins transfer the load from the common rafters into the principal rafters. The lower set of purlins, measuring 7”x 8 ¾”, are located below the struts that extend from the base of the king post. The middle purlins, of similar size, are located below the connection point between the queen post and the principal rafters. The upper purlins are located below the struts that radiate from the base of the king post. Each set of purlins carries across two truss sets and joins to every other principal rafter with a through-tenoned connection.
The principal rafters, which measure 8” x 10”, join into the joggles at the head of the king posts. The common rafters support the roof sheathing between the principal rafters and measure 2” x 6 ¼”, spaced 1’-9” on center. At the apex the common rafters are mortised-and-tenoned together and secured with a single peg.

Ceiling joists run perpendicular to the tie beam between each truss set. The joists measure between 2” and 2½” wide, spaced 1’-4” on center, and mortised-and-tenoned into the tie beam. The joists are pit sawn on the sides and adzed on the upper face.

**Middleton-Pinckney House**

Constructed in 1796 for Major General Thomas Pinckney and his wife, Mrs. Frances Motte Middleton, the brick, three-story Middleton-Pinckney house is renowned for the octagonal projection on its front façade. The hipped roof with flared eaves is supported by a series of king-and-queen post trusses. The roof framing of the Middleton-Pinckney House

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closely resembles the king-and-queen post truss designs described by Price that include a short principal rafter that extends from the tie beam to the queen post joggle, below a long principal rafter that extends from the tie beam to the apex.

In this roof frame, the queen posts measure 3 ⅝” x 7 ¾”. From the joggle at the base of the queen post, struts measuring 3 ⅞” x 8” extend to short principal rafters. These short principals measure 5 ¾” x 6 ⅜” and are mortised-and-tenoned into the joggle at the top of the queen post. Long principal rafters measuring 3 ½” x 9 ¾” extend from the tie beam to the joggle at the top of king post where the members are joined with a mortise-and-tenon connection.24

A collar tie extends between the queen posts 5’-9 ¾” above the tie beam. The connection between the collar tie and the queen post has been obscured by the addition of modern steel plates. Presumably, the collar tie acts as the tie beam for the king post truss that is mortised-and-tenoned into the beam.

Common rafters are spaced 1’-4” on center between the principal rafters. The common rafters exhibit a taper, measuring 3” x 7 ¾” at the base and 2 ⅞” x 5 ½” on average at the apex. The common rafters are butted and nailed to a ridgeboard that runs between the king-and-queen post truss sets.25

24 All connections between the framing members of the Middleton-Pinckney roof are obscured by the addition of modern metal plates.
25 The installation of a finished floor and plaster ceilings make it difficult to understand the structural composition of the framing system in its entirety. Critical information about the tie beam and the purlins could not be determined when this site survey was conducted.
Figure 5.8: A section cut through the attic of the Middleton-Pinckney House reveals a king-and-queen post truss design. In this roof, long principal rafters run on top of short principal rafters. (Drawing by author)
Figure 5.9: The connection between the collar tie and the principal rafters is obscured by metal plates. A visible purlin is through-tenoned into the principal rafter and secured with a wood peg. (Photograph by author)

*Joseph Manigault House*

The Joseph Manigault House was allegedly designed by Gabriel Manigault and constructed in 1803 on the corner of Meeting Street and John Street for Gabriel’s brother, Joseph Manigault. The three-story house was designed in the manner of a Neoclassical suburban villa with curvilinear bays on the north and east façades. The roofline includes a hipped gable roof with two internal brick chimneys. The roof framing system adopted to achieve the 28 ft span of this large residential house is a curious combination of a queen strut roof and a king-and-queen post truss roof.

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The Joseph Manigault attic contains four king-and-queen post truss sets. Two truss frames are located on each side of the two internal chimneys. The queen posts each measure 7 ½” x 5⅛” and extend 7’-0” from the top of the tie beam to the bottom of the collar tie. What makes this truss system unique is the location of the queen posts. A typical king-and-queen post truss design includes queen posts that tie into the principal rafters. Commonly, the collar tie is joined to the sides of the queen post below the connection point between the principal rafters and the post. In the truss system at the Joseph Manigault House the queen posts are joined to the base of the collar tie which runs above the posts and extend past the queen post to the principal rafters. The collar tie, measuring 5 ¼” x 11 ½”, is mortised-and-tenoned into the principal rafters and pegged. A king post is mortised-and-tenoned into the collar tie and extends 4’-0” to the apex of the roof. Struts measuring 5⅛” x 5 ¾” extend from the base of the queen post to the principal rafters. Unlike the other king-and-queen post trusses built in Charleston around the turn of the nineteenth century, no struts extend from the base of the king post to the principal rafters. Iron straps are not employed to reinforce the connection between the tie beam and the queen posts.
Figure 5.10: A section cut through the attic at the Joseph Manigault House reveals a variation of the king-and-queen post combination truss design. (Drawing by author)
The principal rafters measure 5” x 10 ½” and extend from the tie beam to the top of the king post where they are joined with a mortised-and-tenoned connection. Between the principal rafters, common rafters extend to the apex of the roof where they are butted and nailed to a ridged board. The common rafters measure 3” x 6⅛” and are spaced 1’-6” on center. The feet of the common rafters sit on a wall plate above the masonry wall.27

The hipped ends of the roof are formed with hip rafters. Each hip rafter tapers from 4½” x 9⅜” at the base to 4 ¾” x 8⅞” at the ridge. The top of the hip rafter is butted and nailed to the diamond-shaped top of the king post.28

**Figure 5.11:** At the hipped end, hip rafters and principal rafters connect to the head of the king post at the Joseph Manigault House. (Drawing by author)

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27 Brick infill has been placed on top of the wall plate between the common rafters, thereby prohibiting the measurement of the wall plate. The connection between the common rafter and the wall plate cannot be seen.

28 A finished floor prevents the flooring system from being studied. Similar design precedents in Charleston during this time frame suggests the hip rafters sit on a girder which connects to a dragon beam.
Although the framing system at the Joseph Manigault House resembles the king-and-queen post truss designs seen in other large buildings in Charleston during this time period, it is likely that this roof form is not acting as a truss. On first glance, the position of the queen posts and the absence of metal strapping indicate the posts may be acting in compression rather than tension. In a truss roof it is critical for the posts to act in tension so they can “truss” up the tie beam and prevent deflection. A finished floor prevents the study of the flooring system, including the tie beam. Further study of the flooring system is required to determine if the roof is in fact acting as a truss roof form or if it simply acting as a frame roof.

Figure 5.12: Inclined struts are mortised-and-tenoned into the joggle of the queen post and secured with a peg at the Joseph Manigault House. (Photograph by author)

29 The installation of finished flooring obscures the connection between the queen post and the tie beam from view. It is assumed that the queen post is mortised-and-tenoned into the tie beam and secured with wooden pegs. However, further research is required to confirm whether or not this is the type of joint connection used.
Nathaniel Russell House

The Nathaniel Russell House was finished in 1808 for Nathaniel Russell, a prominent Charleston merchant. The three-story brick house features a semi-circular bay on the south façade and measures 31'-3 ½" wide by 62'-3" long. The hipped roof is supported by a king-and-queen post truss technique.

![Figure 5.13: The base of the queen post is obscured by the installation of a finished floor at the Nathaniel Russell House. (Photograph by author)](image)

Two queen posts, spaced 8'- ¾" apart, measure 7 ¾" x 8". These queen posts are mortised-and-tenoned into the principal rafters and secured with two pegs. Unlike other king-and-queen post truss roofs, the collar tie is joined to the principal rafter above the queen post with a mortise-and-tenon joint and secured with two pegs. The collar tie

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Poston, Buildings of Charleston, 261-262. Exterior building measurements exclude the octagonal wing present on the south façade.
measures 3⅞" x 11½" and supports a tapered king post. The king post is mortised-and-through-tenoned and secured with two pegs. The base of the king post measures 11 ½” wide and tapers to a diamond-shaped head. As with the Joseph Manigault House, the absence of iron strapping and the placement of the collar tie in relation to the queen posts and principal rafters, makes it unclear whether the frame is acting as a truss or not.

Principal rafters measuring 3 ¼” x 10¾” are received by the joggles at the head of the king post with a mortise-and-tenon joint and secured with two pegs. Common rafters, spaced 1’-3” on center, carry the sheathing between the principal rafters. On average, the common rafters measure 3” wide by 3 ½” deep. The common rafters sit on a large square timber that acts as a false plate for the feet of the rafters to sit on. Finished floor and plaster walls disguise the flooring system and the location of the purlins. Further study of these hidden members is required to understand the structural behavior of the roof system.

**Figure 5.14:** In the Nathaniel Russell House, the common rafters sit on a large timber acting as a false plate. (Photograph by author)
Figure 5.15: A section cut through the attic at the Nathaniel Russell House reveals a variation on the king-and-queen post combination truss. (Drawing by author)
Conclusion

The queen post trussed roof and the king-and-queen post combination trussed roof developed from a search for more economical roof designs. In England, a lack of available timber led designers and craftsmen to develop trussed roof forms that required shorter lengths of principal rafters and lighter tie beams. The queen post truss was the most commonly adopted economical answer. Although the colonists were not concerned with a lack of available timber in America, the economical queen post trussed roof was adopted for the construction of large building spans in the New World. The queen post truss and queen post truss variations were slowly accepted in England and the British colonies. By the start of the nineteenth century, the queen post truss and the king-and-queen post truss were the most popular method for construction large building spans in Charleston.\textsuperscript{31}

By the mid-eighteenth century, the queen post truss design emerged in Charleston with the construction of St. Michael’s Church. Then, for the next forty years, the king post truss reigned as the predominant trussed roof form. It was not until the 1790s when the queen post and the king-and-queen post truss forms re-emerged with the 1792 reconstruction of the Courthouse and the Middleton-Pinckney House constructed in 1796. After 1800, the king-and-queen post combination truss was the most popular trussed roof form used in the construction of large buildings. This economical design was adopted for a wide variety of buildings including churches, public buildings and large residential houses until the mid-nineteenth century. The queen post truss and its economy would inspire continued development of the trussed roof form into more sophisticated variations that relied on iron trusses. These iron truss roofs superseded the timber framed trussed roofs of the eighteenth and early nineteenth century.

\textsuperscript{31} Yeomans, \textit{The Trussed Roof}, 127.
CHAPTER SIX

THE RAISED TIE BEAM TRUSS

King and queen post trusses enabled the construction of ecclesiastical, civic, and residential structures with building spans in excess of thirty feet. These truss systems provided necessary support to the tie beams whose function was to resist the outward thrust of the exterior walls and hold up the plaster ceiling below the tie. These truss technologies were appropriate for flat ceilings and vaulted ceilings that were constructed below the wall plate. A different framing solution was required for buildings with large building spans and vaulted ceilings that projected above the wall plate into the attic space.¹ The structural solution most commonly adopted in Charleston to solve this spatial problem was the raised tie beam truss system.

Preliminary studies reveal that raised tie beams appeared in Charleston in church buildings and large public buildings at the beginning of the nineteenth century.² The Old Exchange, South Carolina Society Hall and First Scots Presbyterian Church are examples of raised tie beam truss roofs in the city. The raised tie beam design, like the king and queen post truss designs, has origins in Italian and English design. These design influences can be seen in the raised tie beam trusses constructed in Charleston, but each truss exhibits unique regional characteristics that distinguish the raised tie beam trusses of the southern coastal city from those of European antecedents.

² Further investigation of surviving buildings constructed between 1740 and 1820 may reveal that the raised tie beam was constructed prior to the nineteenth century.
History of the Raised Tie Beam Truss

The raised tie beam design developed from the scissor-braced common rafters used in the construction of medieval churches that contained projecting vaulted ceilings or ceilings that were open to the attic to expose the roof framing members.\(^3\) Typically, the building spans of these medieval churches were not large enough to require the use of a tie beam. In addition to the building span, the outward thrust of the roof was distributed over a number of common rafters and down into thick masonry walls which were capable of resisting deflection, further negating the need for a tie beam. The absence of a tie beam allowed the construction of vaulted ceilings that extended into the attic space without interfering with the placement of critical structural timbers.\(^4\) The movement towards Neoclassical design coincided with increased building spans, shallower roof pitches, and decreased exterior wall thickness, all of which lead to the inclusion of a tie beam as a critical structural component to the roof framing system.

In eighteenth and nineteenth century England, raised tie beams were used primarily in the construction of ecclesiastical structures that contained vaulted ceilings. In contrast to the steeply pitched Gothic cathedral roofs, these English designs commonly featured a roof pitch of forty five degrees or less. Raised tie beams were commonly supported by king post, queen post, or king-and-queen post truss systems. A number of pattern books and carpenter’s manuals helped to popularize this complex structural solution through the illustrations of a variety of raised tie beam designs such as those drawn by Francis Price in

\(^3\) In medieval churches and hall houses, the open roof was preferred both for its decorative appeal and for structural purposes. In England, open roofs were the predominant structural framing form used in medieval architecture. Open roof framing technology culminated with the hammerbeam roof frame which was described by French Architect Viollet le Duc as “the pinnacle of English carpentry.” David Yeomans, *How Structures Work: Design and Behaviour from Bridges to Buildings* (Oxford, UK: Wiley-Blackwell Publications, 2009), 174.

\(^4\) Yeomans, *The Trussed Roof*, 128.
In America, raised tie beam designs appear in carpenter’s manuals in the last quarter of the eighteenth century. One such manual, *The Rules of Work of the Carpenter’s Company of the City and County of Philadelphia,* was published in 1786 and demonstrated a raised tie beam truss that was trussed up by a king post truss; a structural design capable of supporting a building span of sixty feet. This truss design featured diagonal beams spanning from the wall plate to the bottom of the king post which created space for a vaulted ceiling of notable size below the tie beam. Builders relied on the iron strapping to secure the connections between the king post and the tie beam, as well as the connection between the diagonal beams and the tie beam.⁶

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⁵ Yeomans, *The Trussed Roof,* 128.
⁶ In the design manual the diagonal beams that span from the wall plate to the tie beam are referred to as hammer-beams. Asher Benjamin, *The Country Builder’s Assistant, Plate 29* (Bedford, MA: Applewood Books, 1989: Originally published: Greenfield, MA: Thomas Dickman, 1797).
Figure 6.2: Raised tie beam design that depends on iron strapping to secure the connections between the tie beam and the other timber members. (The Rules of Work of the Carpenters’ Company of the City and County of Philadelphia, 1786)

The implementation of the raised tie beam design in Charleston in the eighteenth and nineteenth centuries made the construction of building spans greater than sixty feet possible for buildings with projected vaulted ceilings. This new truss form, coupled with a change in preferred roof pitch, precipitated a change in the form and structural behavior of the truss.7

Structural Composition of the Raised Tie Beam Truss

In order to accommodate a vaulted ceiling, the tie beam could be raised above the projected ceiling with the use of diagonal bracing beams. These braces rested on top of the wall plate below the principal rafters and attached to the underside of the tie beam.8 The

7 Yeomans, The Trussed Roof, 128.
8 Price called these braces hammerbeams in the text that accompanied his drawings. This was an unconventional use of the term, which is usually reserved for describing a timber member used to support a hammer post. Typical definition of hammerbeam provided by NW Alcock, M W Barley, P W Dixon, and R A Meeson, eds., Recording Timber-Framed Buildings: An Illustrated Glossary (York, England: Council for British Archaeology, 1996), G8, F8. Yeomans, The Trussed Roof, 130.
straight tie beam extends from one principal rafter to the opposite rafter pair. The tie beam can be supported by a king post, queen posts, or a king-and-queen post truss frame.9

Raising the tie beam solved the spatial complications relating to vaulted ceilings that projected above the wall plate. However, the raised tie beam created new structural problems in the principal rafters and the connections of timber members at the wall plate. Outward thrust of the principal rafters could be effectively restrained as long as the tie beam was not raised too high. The implementation of the raised tie beam did not prevent the risk of bending in the principal rafters. Therefore, to mitigate bending, the method of connecting the timber frame members at the wall plate had to be revised from previous methods.10

In a typical king or queen post truss roof the tie beam restrained the feet of the principal rafters and prevented the outward thrust of the exterior walls. A mortise-and-tenon joint ordinarily secured the connection between the tie beam and the feet of the principal rafters. This joint placed the tie beam in tension which thereby allowed the tie beam to effectively restrain the top of the walls and the principal rafters.11

The construction of a raised tie beam roof meant the mortised-and-tenoned connection between the tie beam and the principal rafters could no longer be used to transmit forces. This is because the pegs used to hold the connection point together proved

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9 In England, raised tie beam truss frames can consist of a straight tie beam supported by diagonal beams, or the raised tie beam can consist of two diagonal tie beams that join to the base of a king post. The former design closely resembles the raised tie beam trusses constructed in Charleston, but roof frames bearing resemblance to the latter design were discovered.
10 Yeomans, The Trussed Roof, 128.
11 Yeomans, The Trussed Roof, 130.
inadequate for the tensile force the joint was required to transmit. To supplement the wooden pegs, iron strapping was used to support the mortise-and-tenon connection between the principal rafters and the tie beam. The U- straps passed around the back of the rafters and fixed through the tie beam with iron bolts.\textsuperscript{12}

\textbf{Figure 6.3}: Illustrations by Francis Price in \textit{The British Carpenter} (1733) for raised tie beam truss designs. (David Yeomans, \textit{The Trussed Roof}: Its History and Development, 110)

\textsuperscript{12} Iron bolts were not used in place of wooden pegs in the mortised-and-tenoned connections because the thin tenon could have failed in shear along the grain if they had been used. Yeomans, \textit{The Trussed Roof}, 129.
Although the raised tie beam restrained the principal rafters, the rafters could still bend outward below the tie beam. To prevent bending in the portion of the principal rafters below the tie beam, braces were added. These braces also provided additional restraint to the top of the walls to prevent outward thrust. If the principal rafters began to bend the braces would be put into tension as long as the proper joints were used to connect the braces with the raised tie beam.\textsuperscript{13}

\textbf{Figure 6.4}: A design by Owen Biddle for a raised tie beam truss roof which accommodates a vaulted ceiling that projects above the wall plate into the attic space. (Owen Biddle, \textit{Biddle's Young Carpenter's Assistant}, Plate 24)

\textbf{The Charleston Raised Tie Beam Truss}

Complex raised tie beam truss roofs were utilized to span large public structures in Charleston beginning in the mid-eighteenth century with The Exchange. The South Carolina Society Hall, constructed in 1804, featured a simplified raised tie beam design. Completed in 1814, First Scots Presbyterian Church was constructed with a raised tie beam supported by

\textsuperscript{13} Yeomans, \textit{The Trussed Roof}, 129-130.
a king post and two secondary posts. Each truss design displays unique construction characteristics that distinguish these Charleston roof frames from those of European origin.

**The Old Exchange**

In 1767 construction began on an Exchange and Custom House on the site of the original Half Moon Battery at 122 East Bay Street. Drawings for the new impressive two-story building over a full basement with arcaded openings were prepared by William Rigby Naylor, an Anglo-Irish draftsmen. The first and second stories featured rusticated openings, pedimented pavilions with Ionic pilasters and columns, and a projecting stair tower with Venetian windows. A Neoclassical stone parapet disguised the hipped roof with slate shingles. The first floor plan included a large open room reserved for the exchange of commodities and the second floor contained a great hall which, according to historian Jonathan Poston,“served as the center of the city’s social life.”

The great hall, or ballroom, on the second floor in the center of the building extended the full width of building from east to west. According to the specifications provided by the building commission, the ballroom included a cove ceiling that extended six feet above the wall plate into the attic space. In order to accommodate the projected cove ceiling, builders employed a complex raised tie beam truss design. This design consisted of a series of king post truss frames interconnected with crisscrossing struts. The tie beams for each truss frame ran perpendicular to one another, creating a grid of trusses suspended above the vaulted ceiling of the ballroom.

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Figure 6.5: The second floor ballroom spans the building width of the Exchange Building and features a cove ceiling that protrudes six feet above the wall plate. (Photograph by author)

On October 12, 1767, the *South Carolina Gazette* reported the minutes of the board of commissioners meeting during which Peter and John Horlbeck were chosen to construct Naylor’s designs for the new Exchange Building. The Horlbeck brothers completed the construction of the Exchange in accordance with Naylor’s designs, except for the roofline which was changed to a gambrel roof from the hipped roof specified in the drawings. The Horlbecks used the roofline most familiar to them from their hometown of Saxony, England, where the gambrel roof style dominated the landscape. Although the profile of the roofline was altered, the builders adhered to other specification for the roof frame assembly.16

The specifications called for floor joists that measure 3"x14", girders that measure 8"x12", and bond timbers that measure 6"x9". Additionally, the principal rafters are called out as 8"x10", the common rafters were to be 3"x6" and the purlins to be 8"x8". The common rafters have since been replaced with modern framing members, but the remaining timber members confirm that the construction of the attic framing members conformed to the requirements of the building contract.\textsuperscript{17}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image.jpg}
\caption{A king post and two secondary posts support the raised tie beam. A series of crossing struts connect the king post and the secondary posts to one another. (Photograph by author)}
\end{figure}

\textsuperscript{17} WHJ Thomas, \textit{South Carolina’s Historic Exchange Building}, 9.
Figure 6.7: Cross bracing made of a series of posts and struts intersects the primary king post truss frames to create a grid suspended above the projecting vaulted ceiling. (Photograph by author)

The addition of modern steel trusses and heating and air conditioning systems has obscured the structural behavior of the historic trusses. Critical joint connections are now hidden from view. Therefore, supplemental research was gleaned from the original construction specifications as well as from scholarly publications on the construction of Charleston’s Exchange Building. Further study is required to understand the true structural behavior of this complex raised tie beam truss roof.

South Carolina Society Hall

Constructed in 1804 at 72 Meeting Street, South Carolina Society Hall was allegedly designed by Gabriel Mangualt as a Neoclassical hall for French Huguenot businessmen and artisans. The T-shaped building features two full stories over a full basement with an intersecting gabled roof. The second floor plan includes a ballroom that measures 29’5” wide and 52’6” long and features a vaulted ceiling that projects into the attic space. In 1825,
a pedimented portico was added to the building that projects over the sidewalk.\textsuperscript{18} In order to accommodate the projected vaulted ceiling and the large open span of the second floor ball room, the tie beam in the South Carolina Society Hall building had to be raised above the wall plate.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure68.jpg}
\caption{The second floor ballroom in South Carolina Society Hall features a vaulted plaster ceiling which projects above the wall plate into the attic space. (Photograph by author)}
\end{figure}

A king post and two secondary posts create a frame that is used to support the raised tie beam. In a typical truss roof, the truss frame spans the width of the open space. In South Carolina Society Hall the truss frame stretches the length of the ballroom. This unique truss design holds the raised tie beam which measure 9” x 9” and spans 23’10” between the principal rafters. The principal rafters each measure 7⅝” x 9¾” and extend from the wall plate to the joggle at the head of the king post. The king post is mortised-and-tenoned into

\textsuperscript{18} Jonathan H. Poston, \textit{The Buildings of Charleston}, 182.
the tie beam and secured with a wrought iron U-strap. Struts measuring 6” x 8” extend from the joggles on the base of the king post to the principal rafters were they are mortised-and-tenoned together and secured with a wooden peg.

**Figure 6.9:** The king post is strapped to the tie beam with a wrought-iron U-strap that is stamped with the number “3” and secured with iron bolts. The joggles on the base of the king post receive struts which support the principal rafters to prevent bending. (Photograph by author)

**Figure 6.10:** The connection between the tie beam, principal rafters, and the secondary post is secured with a series of iron U-straps and bolts. (Photograph by author)
Figure 6.11: A section cut through the attic of South Carolina Society Hall reveals a variation on a raised tie beam truss. (Drawing by author)
Secondary posts are mortised-and-tenoned on top of the principal rafters and secured with a wrought iron U-strap that is fixed to the sides of the queen posts and loops around the tie beam. A strut extends from a joggle at the top of each secondary post to the principal rafter where the strut is secured with a mortised-and-tenoned joint. A ridgeboard is set behind the plane of the posts and runs the length of the truss frame to accept the common rafters. Principal rafters run perpendicular to the truss frame and join to the front façade of the head of the king and queen posts.

*First Scots Presbyterian Church*

Constructed in 1814, First Scots Presbyterian Church, located at 53 Meeting Street, utilizes a modified king post truss with secondary posts to support the weight of the roof and achieve the necessary building span. The tie beam is comprised of two wooden members scarfed together and secured with iron straps and bolts. At the center of the tie beam the king post is secured with a mortised-and-tenoned joint and a wrought-iron U-strap. The head of the king post is suspended from the principal rafters with a mortised-and-tenoned joint and secured with iron reinforcement. Here, the iron bars are shaped like an arrow and spiked into the timbers to secure the connection between the king post and the principal rafters. A pair of struts extends from either side of the lower joggles on the king post to the upper joggles of the secondary posts, dividing the tie beam support into thirds. Struts extend from the lower joggle of the secondary posts to the principal rafters to prevent bending in the lower region of the rafters. Lower purlins are through-tenoned into the principal rafter with the common rafters lapped over the purlins. Every other bay contains an upper purlin fixed to the principals in the same manner as the lower purlins. As with the simple king post truss roof, the role of the purlins is to transfer the load of the roof away from the common rafters and into the principal rafters.
Figure 6.12: To accommodate a vaulted ceiling that extends above the wall plate into the attic space, a raised tie beam is constructed. The tie beam is supported by a king post and two secondary posts. (Photograph by Willie Graham, Colonial Williamsburg Foundation)
The connection between the principal rafter and the tie beam is a unique one which merits further study. A bent hewed wooden piece spans across the tie beam and principal rafter to solidify the connection, and is secured with iron bolts. The bent wooden piece is an unexpected feature because iron was readily available by the nineteenth century and would have been a stronger material.

Figure 6.13: A bent, hewed wood timber is bolted to the tie beam and the principal rafter to provide additional support to this critical connection. (Photograph by Willie Graham, Colonial Williamsburg Foundation)

19 The grain on the timber strap suggests this member was selected from the crooked portion of a tree. Further study is required to understand the origins of this bent timber member and its intended structural benefits.
Conclusions

The raised tie beam truss frames constructed in Charleston are complex systems for which the structural behaviors of each roof design is unclear. The raised tie beam frames used in the Old Exchange and South Carolina Society Hall each exhibit unique characteristics. The English and American pattern books illustrated raise tie beam designs for use in churches and large civic buildings. In Charleston, church buildings with vaulted ceilings were not always accommodated with raised tie beam truss roofs. Instead, the exterior walls were extended upwards to match the height of the vaulted ceiling. A straight tie beam was then joined to the principal rafters on the wall plate and carried across the top of the vaulted ceiling.

When raised tie beams were constructed, they were carried by a complex series of king posts, secondary posts, and inclined struts. Iron strapping was always used to ensure the posts acted in tension, thereby “trussing” the tie beam effectively. As technology progressed in the nineteenth century, builders relied on iron strapping as well as iron rods, which began to replace the heavy timber frame members of the eighteenth and early nineteenth century roof frames.

Each Charleston raised tie beam identified has since been supplemented with modern steel truss systems, indicating that these historic designs did not effectively support the tie beams or the weight of the vaulted ceilings below them. The addition of modern systems has obscured the historic truss frames, making it difficult to understand the structural behaviors of these systems in their entirety. Further study for each raised tie beam truss identified should be conducted to better understand the intention behind each design.
CHAPTER SEVEN

CONCLUSION

The trussed roof was a critical advancement in seventeenth century British building technology that found its way to Charleston by the middle of the eighteenth century. This new roof structure enabled the construction of greater building spans, facilitated complex and fashionable architectural roof styles, and accommodated large, open interior spaces. This study of trussed roofs in Charleston traces the development of trussed roof designs and the structural composition of the trussed roof. This thesis relies on first-hand observation to classify various trussed roofs constructed in Charleston, South Carolina between 1740 and 1820, and the proliferation of each design. This study illuminates a subject that heretofore has received little attention from architectural historians – the development and implementation of trussed roof technology in Charleston. The results of this survey reflect a development of the trussed roof, over the course of one hundred years, from the most basic king post truss, to a more sophisticated king-and-queen post combination truss design.

The origins of the trussed roof design can be traced to sixteenth century Italy where designers like Andrea Palladio illustrated king post and queen post trusses in pattern books. English designers such as Inigo Jones brought the trussed roof design to England. Through the designs of Jones, Gibbs and Christopher Wren, various trussed roof designs became popular structural solutions to the issues of building span and timber availability in the seventeenth and eighteenth centuries. Soon after the trussed roof received widespread application in England, builders in the British colonies adopted king post and queen post trussed roofs for the construction of large buildings.
Before trussed roof technologies arrived in Charleston, building spans were limited by the structural capabilities of traditional frame roof methods. In Charleston, common rafter roofs were the most popular form of frame roofing and they were typically applied to buildings with spans less than twenty five feet. Principal rafter roofs were commonly constructed for building spans between twenty feet and thirty feet. The largest, double-pile plan buildings employed M-roofs to accommodate building span. The introduction of the trussed roof to the Charleston building tradition drastically improved the architectural and structural capabilities of the local carpenters.

**Survey Results**

This study included on-site surveys of the roof frames constructed for twenty five percent of the ninety eight surviving Charleston buildings that were constructed with a building span greater than twenty five feet between 1740 and 1820. Of these surveyed properties, four properties were constructed as churches, six buildings were erected for civic or public use, and fourteen were built as residences.

![Figure 7.1: Left Graph: Surviving buildings constructed between 1740 and 1820 with a building span greater than twenty five feet categorized by original use. Right Graph: Buildings surveyed for this study categorized by original use. (Drawings by author)](image-url)
Trussed roof technology arrived in Charleston by the mid-eighteenth century and remained a popular roofing form into the nineteenth century. The earliest use of a trussed roof discovered by this research was a king-and-queen post combination truss roof employed in the construction of St. Michael’s Church in 1751. By the 1760s, a king post truss design was used in the construction of the Blake Tenements, and a complicated adaptation of a queen post truss design was employed in the construction of the Miles-Brewton House. Over the next thirty years, the king post truss remained the most popular trussed roof form for large Charleston buildings. However, in the 1790s the king-and-queen post combination trussed roof became common in the construction of civic and residential buildings. From 1796 to 1820, the king-and-queen post combination truss was the most popular trussed roof form for churches, civic buildings, and residential structures. A breakdown of the trussed roof forms constructed in Charleston, as they relate to the use of the building and the year of construction, is provided in Figure 7.2.

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1Further research will need to be conducted to determine the first trussed roof constructed in Charleston.
Figure 7.2: The relationship between time and roof typology is shown in this graph. (Drawing by author)
A timeline comparison of trussed roof construction in Charleston to those built in London reveals that some roofing technologies disseminated to the southern colonial city relatively quickly, while other technologies were adopted more slowly. An examination of available research on colonial American trussed roof design reveals Charleston's adoption of the trussed roof happened slightly later than other major colonial American cities such as Philadelphia, Boston and New York. A study of available pattern books in Charleston during the eighteenth century reveals that carpenters had access to a number of pattern books depicting trussed roof designs by the mid-eighteenth century, including Francis Price’s *The British Carpenter* published in 1733.²

The survey results indicated that certain frame roof technologies, such as the common rafter and principal rafter roofs, continued to be used after 1740 for the construction of building spans less than thirty feet. The M-roof framing technology however, was largely replaced with the introduction of trussed technologies. After 1740, trussed roofs were the predominate method of roof framing for buildings with spans greater than thirty feet. As the graphs in Figure 7.3 indicate, the common rafter roof was still the most common form of frame roof between 1740 and 1820. The most common trussed roof constructed in the these decades was the king-and-queen post truss.

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Figure 7.3: Left: Frame roof typologies constructed between 1740 and 1820 in Charleston. Right: Truss roof typologies constructed between 1740 and 1820 in Charleston. (Drawings by author)

Figure 7.4: Upper Left: The location of all of the truss roofs identified in this study. Upper right: The location of king post truss and king post truss variations. Lower Left: The location of the queen post truss roofs. Lower right: The location of the king-and-queen post combination truss roofs. (Drawings by author)
Regional Trussed Roof Characteristics

Unsurprisingly, the trussed roofs constructed in Charleston exhibit similarities with the trussed roofs of England and other American colonies. However, the Charleston trussed roof exhibits unique regional characteristics. Many construction techniques distinguish Charleston trussed roofs from those of large colonial cities such as Boston, New York, and Philadelphia as well as those erected in Maryland and Virginia.

Regional comparisons between the construction technologies used in Charleston to those used in Virginia and Maryland reveal several differences, the first of which relates to the use of a ridgeboard at the apex of the roof. According to architectural historian Willie Graham, ridgeboards were implemented to reduce the amount of time a carpenter had to spend cutting precise ridge joints for the common rafters, which were structurally less important than the principal rafters or the trussed members. This technology was used in Maryland as early as 1775 when John Brice III used a ridgeboard in the low-pitched common rafter roof for his Annapolis house. By the mid-nineteenth century, the adoption of lightweight metal roof coverings enabled the ridgeboard to become standard construction practice for common rafter, principal rafter, and king post truss roofs.3 Constructed in 1803, the Joseph Manigault House contained the earliest ridgeboard found in the surveys conducted for this study. Although further research is required to confirm whether or not the Joseph Manigault House was the first building to utilize a dropped ridgeboard, the research collected indicates Charleston developed this construction technology later than other colonial American colonies.

Many of the king post trussed roofs constructed in Charleston use a dropped ridgeboard, or ridge beam, to stabilize the king posts and align the common rafters with each other. Dropped ridgeboards have been found in the Blake Tenements, the Miles-Brewton House, and the Heyward Washington House. The results of this study reveal the dropped ridgeboard was a construction method used in the 1760s and 1770s. After 1780 this technique is no longer found in trussed roof construction in Charlestown. This construction method was unique to Charleston and other places in the lowcountry such as Beaufort, South Carolina. This local practice was likely used as a bracing mechanism to stabilize the roofing members until construction was complete. Score lines found on the ridgeboards, or beams, align with the placement of the common rafters which suggests these timber members were also used as place markers in the assembly of the roof rafters.

Another construction feature unique to the region is the method of installing iron U-straps. In a trussed roof the supporting post is commonly smaller than the tie beam on which the post sits. To ensure a trussing action, the supporting post is strapped to the tie beam. To accommodate the difference in width of the two timber members, English carpenters often threaded the strap through slits cut into the tie beam and bolted the U-strap to the sides of the supporting post. Trussed roofs in Charleston reveal that the local builders chose a simpler method in which they chiseled out notches in the sides of the tie beam to accommodate the iron U-strap or simply furred out the strapping on the sides of the posts.4

Raised tie beam construction was introduced to accommodate vaulted ceilings with trussed roof systems. These designs were introduced in early eighteenth century books,

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many of which were available in the American colonies. Despite the availability of these designs, the results of this study indicate that Charleston carpenters did not adopt raised tie beam trussed roofs until the nineteenth century. South Carolina Society Hall, constructed in 1803, is the earliest raised tie beam trussed roof found through the research conducted for this study. Prior to the nineteenth century, carpenters in Charleston accommodated vaulted ceilings by raising the exterior walls above the projected ceiling, which allowed the tie beam to tie into the wall plates directly. Preliminary research of colonial American trussed roofs reveals that Charleston adopted the raised tie beam trussed roof significantly later than other colonial cities. For example, raised tie beams were used in the construction of Christ’s Episcopal Church in Shrewsbury, New Jersey in 1769, Old Drawyers Presbyterian Church in Odessa, Delaware in 1772, and in St. Peter's Church in Philadelphia, Pennsylvania in 1758.5

Many of the king-and-queen post trussed roofs constructed in Charleston are distinguishable from other English and early American trussed roofs of similar design. Price’s eighteenth century illustrations of a king-and-queen post trussed roof closely resemble the trussed roof form found in Charleston, in which the king post above the collar tie does not receive additional support from struts. Unlike Price’s design, the Charleston king post in a king-and-queen post combination is rarely tied to the collar tie with an iron U-strap. Instead, the king post is simply tied to the collar with a mortise-and-tenon joint and secured with two or four pegs. Through his research of trussed roofs in Virginia and Maryland, Graham reveals king-and-queen post trussed roofs in these regions typically

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included a king post above the collar tie that was supported by two struts radiating from the base of the post.6

**Further Study Questions**

The examination of trussed roof construction in Charleston raises a number of additional questions and future research opportunities. Further research regarding Lowcountry trussed roof designs will shed light on the connection between Lowcountry design, early American design, and English design. Further study should also be conducted to determine the relationship between the architect and the carpenter in the design and construction of trussed roofs. Additional research will help to solve many unanswered questions regarding trussed roof design and the implementation of these technologies in eighteenth and nineteenth century Charleston.

These unanswered questions include the following: Who was responsible for the trussed roof design? Who decided the size, shape, and orientation of the timber members used to construct the trussed roof? Did craftsmen understand the structural behaviors associated with these trussed roof designs? Was the construction of trussed roofs trial-and-error, or a reflection of tried and true engineered design?

The methods through which new structural ideas and technologies were disseminated to Charleston could be studied further to gain a better understanding of the ways in which architects and carpenters learned of new trussed roof designs. Were Charleston builders aware of the construction technologies employed in other colonial cities? Was the type of roof constructed a source of pride amongst builders? Did Charleston carpenters employ specific truss roof designs because they were familiar with the designs

---

or because they wanted to keep up with the latest trends from London? Was there a direct link between Charleston design and other colonial colonies, or were these structural ideas brought directly from England?

Structural analysis of these historic trussed roofs should be conducted to determine the structural efficiency of these framing systems. Many of the roofs surveyed for this thesis have been supplemented with modern steel bracing, indicating that these historic trussed roofs are structurally failing. Further research could provide critical information to confirm whether these trussed roofs are failing or not. If so, why are they failing? How can failure be prevented? If timbers need to be repaired or replaced, what are appropriate treatment options?

**Conclusion**

The implementation of trussed roofs in Charleston is a fascinating subject that results from a confluence of social, cultural, and economic factors. The city’s wealth and prosperity spawned the construction of many large public and private buildings, the size and scale of which were unrivaled in smaller colonial cities. The development of the trussed roof enabled the construction of Charleston’s most notable buildings including St. Michael’s Church, the Miles-Brewton House, the Old Exchange, the Courthouse, and the Heyward-Washington House. Socio-economic factors placed Charleston at the leading edge of construction technology, and therefore the coastal city is a critical component in the development of American building forms and the roof framing technologies that enabled the construction of these modern structures.
APPENDIX A

ILLUSTRATED GLOSSARY
ADZE
(Synonym: Adz, ads, adds)
A tool used to remove large surface areas when squaring timbers. An adze is a long-handled tool with the metal blade set at right angles to the wooden handle. Cuts made with an adze are distinguished by scallop-shaped indentions on the timbers.¹

Figure A.1: An adze illustrated by Joseph Moxon is Mechanick Exercises. (Moxon, Mechanick Exercises...1703, Library of Congress)

Figure A.2: Scalloped indentions on a principal rafter at the Heyward-Washington House indicate the use of an adze to square the timber. (Photograph by author)

APEX
(Synonym: Ridge)
The upper edge of the location at which two sloping surfaces of a roof converge to form a horizontal line.\(^2\)

Figure A.3: View from the Nathaniel Russell house of the apex of the roof on a Charleston single house. (Photograph by author)

\(^2\) Lounsbury, 308.
COLLAR TIE
(Synonyms: Collar, Collar Beam, Straining beam, Windbeam)
A horizontal cross beam that ties a pair of rafters together at a level above the wall plate. Collar ties are commonly found in common rafter roofs and queen post truss roofs in Charleston.³

Figure A.4: Collar ties span between common rafters at the Aiken Rhett House. (Photograph by author)

Figure A.5: A section cut through a queen post truss at the Courthouse illustrates a collar tie that spans between two queen posts and supports angled struts. (Drawing by author)

³ Lounsbury, 87.
COMMON RAFTER, COMMON RAFTER ROOF
(Synonym: Small Rafter)
A common rafter roof consists of a series of small, uniform rafter pairs spaced evenly along the length of the roof. The common rafters support the roof sheathing and add rigidity to the roof frame. This type of roof is suitable for smaller building spans. In Charleston, the common rafters typically rest on a false plate, thereby acting independently from the wall-framing system, and the common rafter pairs are linked together by a collar tie at the mid-point of the rafter.

Figure A.6: The common rafter roof constructed at the Aiken Rhett House, c. 1820. Collar ties are mortised-and-tenoned into each common rafter pair. (Photograph by author)

4 Lounsbury, 88-89.
DRAGON BEAM

In southern carpentry, the dragon beam is a diagonal girder that supports the feet of hip rafters at the intersection of two wall plates. In earlier English carpentry, the dragon beam is a diagonal girder that projects out over the corner of the building to support a post and overhang where a building jetties on two sides. In Charleston, hipped rafters are typically supported on short dragon beams such as the one shown below in the Nathaniel Russell House.5

Figure A.7: A short dragon beam supports the hip rafter at the Nathaniel Russell House. (Photograph by author)

5 Lounsbury, 119.
FALSE PLATE

A board, or scantling, that rests on top of the ends of joists or tie beams. The false board supports the common rafters which are commonly butted and nailed together. The false plate allows the roof framing system to be structurally independent of the wall frame. In Charleston roof construction the feet of the common rafters rest on a false plate that typically measures approximately 1” in thickness.

Figure A.8: The common rafters in the Heyward Washington House are butted and nailed to a false plate. (Photograph by author)

---

6 Lounsbury, 136.
FRAME ROOF

According to historian David Yeomans, a frame roof is one in which the structural supporting members are placed in compression, rather than in tension, and therefore no trussing action occurs. In Charleston, the type of frame roofs constructed includes common rafter roofs, principal rafter roofs, and M-roofs. The M-roof describes the form, rather than the structural system.

Figure A.9: The M-roof at Fenwick Hall is one example of a frame roof. This example uses principal rafter style trusses to create the M-shape while others use common rafters to form the M-shape. (Drawing by David Weirick and Lauren Golden)

GIRDER
(Synonym: Girt)
A large, longitudinal framing beam that provides rigidity to the floor frame. Girders commonly span the breadth of the interior space between the outer sills, breaking up the area into smaller units spanned by joists. For large floor spans, the framing is subdivided by summer beams that extend from the end of the sill to an interior girder with a series of subsidiary girders tied into the summers at right angles. Charleston hipped roofs employ a girder to accept the dragon beam below the hip rafters. The girder is angled and ties into the exterior wall plates.

Figure A.10: An unusual angled girder accepts the dragon beam below the hip rafter in the Courthouse roof frame. (Photograph by author)

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8 Lounsbury, 159-160.
HEW
(Synonyms: Hewed)

“To cut, shape, smooth, or roughly square timber or stone with blows of an ax, hammer, or chisel. (adj.) Roughly squared materials such as stone, framing members, logs, or fence posts.”9

Figure A.11: Thomas Martin illustrated tools used by carpenters and joiners in The Circle of the Mechanical Arts, 1813. The tools used for hewing are the axe (7), the hammer (21), and the chisel (13).

9 Lounsbury, 178.
HIP RAFTER

A rafter that forms the hipped end of a roof at the junction of two roof plans. The upper side of the hip rafter is cut at two angles to correspond with the slopes of the two intersecting roof planes.10

Figure A.12: The hip rafter at the Joseph Manigault House is placed at the convergence of two roof planes. (Photograph by author)

10 Lounsbury, 179.
JOGGLE

A wide splay cut into the base or head of a post at a precise angle to receive the ends of struts or principal rafters. The angle cut into the post to receive the struts was a greater angle than the angle cut at the head of the post to accommodate the principal rafter connection. The joggles enabled the king or queen post to be supported by the principal rafters.¹¹

Figure A.13: Joggles cut into the base of the king post truss at Blake Tenements receive struts that enable the king post to be supported by the principal rafters. (Photograph by author)

Figure A.14: Joggles cut into the head of the king post at the Joseph Manigault House receive the principal rafters which suspend the post in tension. (Photograph by author)

JOIST

Horizontal framing members that span the major framing timbers and rest on masonry walls, wall plates, girders, summer beams, or sills. Joists provide support to floorboards above and plaster lath or sheathing boards below.\textsuperscript{12}

\textbf{Figure A.15:} Floor joists run parallel with the tie beams and rest on masonry walls at the Courthouse. (Photograph by author)

\textsuperscript{12}Lounsbury, 197-198.
KING POST

A vertical post in a roof truss that is suspended from a pair of principal rafters at the ridge and connected to the tie beam at the base, thus placing the post in tension. The flared base provides shoulders, called joggles, into which diagonally set struts are tenoned. Occasionally, ridge boards are run longitudinally from one king post head to another to serve as a nailing board for the common rafters.”

Figure A.16: King post trusses frame the roof at the Heyward Washington House. (Photograph by author)

13 Lounsbury, 200.
OUTRIGGER

Short joists running perpendicular to the floor joists. These outriggers are tenoned into the perimeter plate and extend to the wall plate.

Figure A.17: Outrigger joists are mortised-and-tenoned to the perimeter plate at the Heyward Washington House. The outriggers run perpendicular to the floor joists. (Photograph by author)
PERIMETER PLATE

A framing member that runs the perimeter of the roof approximately three feet in from the exterior walls. Where the perimeter plate runs perpendicular to the floor joists, the joists are mortised-and-tenoned into the timber member on either end of the roof. Around the perimeter of the roof, the outrigger joists are mortised-and-tenoned to the timber member and extend to the wall plate. The false plate sits on top of these outrigger joists and receives the feet of the common rafters.

Figure A.18: A tie beam intersects the perimeter plate which accepts the outrigger joists at the Heyward Washington House. (Photograph by author)
PITCH

The angle of a roof which is determined by the proportion of the building span to the height of the roof.\(^\text{14}\) In the eighteenth and nineteenth centuries, a typical roof pitch in Charleston ranged between 30⁰ and 45⁰.

\(^{14}\) Lounsbury, 276.

Figure A.19: This 1733 drawing by Francis Price illustrates three roof pitches: 26 ½⁰, 37⁰ and 45⁰ respectively. (Drawing from David Yeomans, The Repair of Historic Timber Structures)
ILLUSTRATED GLOSSARY

Roof Truss Terminology

PIT SAW, PIT SAWN
Method of sawing timbers using a saw in which one person stands on top of the log being cut and one underneath it. Logs can either be raised on trestles or laid over an excavated hole to provide space for use of a long saw blade. Two sawyers – one on top of the log and one in the pit – use a whip or pit saw to cut the log into separate pieces, stopping short of the log’s end. After all cuts are made the remaining, uncut ends of the boards are split loose. Marks left on the boards that have been pit sawn are characterized by groupings of relatively vertical and straight striations, with marks occasionally changing their angle relative to the board’s edge as the angle of the saw is altered to accommodate the sawyers stepping in the direction of the cut.\textsuperscript{15}

\textbf{Figure A.20:} Men demonstrate pit sawing techniques in which one man stands above the other man to saw timbers. (Image from Library of Congress, www.loc.gov)

\textsuperscript{15} Lounsbury, 275.
PLANE
(Synonym: plain)
A woodworking tools used to shape rough pieces of wood and provide a smooth finished surface. The plane typically contained an adjustable metal blade housed in a wooden body and secured in place with a wedge. Smaller finishing planes were used to smooth surfaces for a finished look. In attic construction, Charleston carpenters often planed the faces of the king posts, queen posts, and principal rafters.

Figure A.21: A typical plane used shape and smooth wooden timbers. (Sketch by author)
_ILLUSTRATED GLOSSARY_

**Roof Truss Terminology**

**PRINCIPAL RAFTER, PRINCIPAL RAFTER ROOF**

A principal rafter is a large diagonal framing member that ties into a rafter pair and forms a triangular truss shape. The foot of a principal rafter is joined into a tie beam that spans the length of the attic. Principal rafter roofs, often called _principal roofs_ or _girt roofs_, were used for modest building spans that could not be supported with a common rafter roof. They were also constructed for buildings that supported a heavy roof covering such as slate or tile. Principal rafters roof were typically constructed with purlins, which transfer the weight of the smaller common rafters in the principal rafters.\(^{17}\)

![Diagram of a typical principal rafter roof](image)

**Figure A.22:** Illustration of a typical principal rafter roof constructed in Charleston. (Sketch by author)

\(^{17}\) Lounsbury, 290.
ILLUSTRATED GLOSSARY

Roof Truss Terminology

PURLIN
A longitudinal roof timber carried by principal rafters that provide support for common rafters or vertically applied sheathing boards. Purlins can be trench ed on the back of the principal rafters, mortised into the sides of the rafters, or clasped between the collar and the principal.\textsuperscript{18}

Figure A.23: Purlins distribute the load of the roof away from the common rafters and into the principal rafters at St. Michael's Church. (Photograph by author)

Figure A.24: Purlin connection types from left to right: 1) Butt Purlin 2) Trenched Purlin 3) Clasped Purlin. (Drawing by author)

\textsuperscript{18} Lounsbury, 298.
QUEEN POST

A pair of posts that sit directly on the tie beam and provide support to the purlins and the principal rafters. A *queen post truss* is a timber member in tension that suspends from the principal rafters and ties to the tie beam, typically with the assistance of metal strapping. *Queen post struts* are a pair of posts that act in compression between the tie beam and the principal rafters or a collar tie.\(^{19}\)

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**Figure A.25**: A section cut through the queen post truss roof in the Courthouse. The queen posts are placed in tension between the principal rafters and the tie beam. (Drawing by author)

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ILLUSTRATED GLOSSARY

Roof Truss Terminology

RIDGE BOARD
(Synonym: Ridge pole, ridge piece)

A longitudinal timber at the apex of the roof, to which the upper ends of rafters are fastened. Such timbers were occasionally used in principal rafter roofs, or between posts in king and queen post truss roofs. In some Charleston truss roofs a dropped ridge board exists between the truss posts approximately twelve inches from the apex of the roof.20

Figure A.26: A thin ridge board at the apex of the roof at the Joseph Manigault house serves as the longitudinal timber member for which the common rafters are butted and nailed to. (Photograph by author)

Figure A.27: The dropped ridge board at the Heyward Washington House is located one foot below the apex of the roof. Score marks on the timber member align with the placement of the common rafters. (Photograph by author)

20 Lounsbury, 308.
ROOF TYPES
The most prominent roof forms constructed in Charleston between 1740 and 1820 include gabled roofs, hipped roofs, and M-roofs. Other roof forms such as the gambrel roof, cross-gabled roof, and cross-hipped roof, were also constructed.

Figure A.28: Various roof forms constructed in Charleston between 1740 and 1820. (Drawing by author)
SASH SAWN  
(Synonym: Mill Sawn)  
A sawmill was a piece of machinery that consisted with a long blade attached to a frame that moved in a reciprocating motion when turned by gears attached to a waterwheel. The mill provided the technology to cut more uniform timber framing members. In Charleston, sash or mill sawn timbers appear in primary roof framing members by the mid-eighteenth century. Secondary members such as common rafters, false plates, and floor joists are not sash sawn until the nineteenth century.  

Figure A.29: The straight, uniformly spaced saw marks present on the principal rafter at South Carolina Society Hall are indicative of mill sawn lumber. (Photograph by author)  

21 Lounsbury, 317.
ILLUSTRATED GLOSSARY

Roof Truss Terminology

SCARF JOINT
(Synonym: Scarf)

A joint in which two members are joined together by means of lapping their ends over one another and securing them with pegs, straps, or bolts. Scarf joints were commonly used to form long horizontal framing members such as tie beams, sills, plates, and purlins. There are a variety of ways in which two members can be joined together using a scarf including a face-halved or side-halved scarf, a splayed scarf, a stop-splayed scarf, or a through-splayed scarf.  

![Figure A.30: Scarf joint variations in timber framing. (Drawing by author from Merriam-Webster online dictionary)](image)

![Figure A.31: A scarf joint is used to tie two timber members together for the tie beam in First Scots Presbyterian Church. Metal straps and bolts are used to secure the joint. (Photograph by Carter L. Hudgins)](image)

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STRUT
(Synonym: Brace)
A timber acting in compression. Struts were often placed at an angle, with the lower part resting on a tie beam, collar beam, or joggle of a king or queen post and the upper end supporting a principal rafter. A \textit{king strut} is a vertical timber that stands on a tie beam and expands to the apex of a roof, while \textit{queen struts} are a pair of struts that are framed between the tie beam and a collar tie, and do not support a longitudinal timber.\textsuperscript{23}

\textbf{Figure A.32}: A strut extends from the joggle of a queen post to the principal rafter at St. Michael's church. (Photograph by author)

\textbf{Figure A.33}: Struts stand on the collar tie and extend to the principal rafters in the Courthouse roof. (Photograph by author)

\textsuperscript{23}Lounsbury, 360; N W Alcott, G18.
SUMMER BEAM
(Synonym: Summer)
A large longitudinal beam that spans the breadth of a building and provides support for the floor. Summer beams are supported by girders and receive the ends of the floor joists at regularly spaced intervals.\textsuperscript{24}

\textbf{Figure A.34}: The summer beam runs the length of the building and provides support to the floor joists. (Sketch by author)

\textsuperscript{24} Lounsbury, 362-363.
TIE BEAM

The principal framing member that connects the front and rear wall plates. The tie beam is the lowest member of a truss in which the feet of the principal rafters are framed, restraining them from an outward thrust against the wall. In a king-post or queen-post truss, the lower end of post(s) act as a tension member, tenoned and often strapped with iron bars to the tie beam to prevent the tie from sagging.25

Figure A.35: In First Scots Presbyterian Church the tie beam is made up of two timbers scarfed together at the mid-point. The tie beam is supported by a complex king post truss with a central king post and two secondary posts. (Photograph by Willie Graham, Colonial Williamsburg Foundation)

25 Lounsbury, 373.
TRUSS ROOF

A roof system in which one or more timbers, acting in tension, help to support the building span. In Charleston, a variety of trussed roof designs were constructed during the eighteenth and nineteenth centuries, include the king post truss, the queen post truss, the king-and-queen combination, and the raised tie beam truss. In these designs, the trussing action depends on the use of iron U-straps that connect to the support posts and loop below the tie beam.

Figure A.36: The base of the king post at the Old Exchange is strapped to the tie beam with an iron U-strap. The tie beam is notched to accommodate the difference in width between the strap and the timber. (Photograph by author)

Yeomans, The Trussed Roof, 28.
WALL PLATE
(Synonyms: Raising piece, Raising plate)
A horizontal, longitudinal timber placed on top of a masonry or frame wall, on which ceiling joists or roof trusses rest. In Charleston roof framing construction, the joists and trussed rest on a wall plate while the common rafters rest on a secondary plate known as a false plate.

Figure A.37: Rafters notch over a wall plate on a masonry wall. (Sketch by author)

27 Lounsbury, 396.
APPENDIX B

PROPERTY INFORMATION SHEETS
### Roof Framing Typology Survey Form

#### 87 Church Street
Heyward-Washington House

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<th>Date of Survey:</th>
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<tr>
<td>Conducted By:</td>
<td>Pam Kendrick, Carter Hudgins, Carl Lounsbury, Willie Graham</td>
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| Exterior Building Length:    | 46'2"                      |
| Date of Roof Framing:        | 1772                       |
| Builder:                     | Unknown                    |

#### Roof Framing Information

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<td>Roof Covering:</td>
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<td>Notes:</td>
<td>Hipped Roof</td>
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| Internal Bearing Walls:   | ✓                          |
| Presence of Ridgeboard:   | □                          |
| Presence of Metal Strapping: | ✓                          |

#### Selected Images

- Staggard through-tenon purlins tie into the principal rafters. The king post struts are tenon and single pegged into the principal rafters. (Photography by author)

- Hand-planed king post truss with hewn and pit sawn struts that are tenoned and double pegged into the joggle of the king post. (Photograph by author)
Roof Framing Typology Survey Form

122 East Bay Street
The Old Exchange

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<td>Presence of Metal Strapping</td>
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**Selected Images**

- A king post is mortised-and-tenoned into the raised tie beam and secured with a metal U-strap. (Photograph by author)
- The addition of modern steel bracing obstructs the view of the original king post truss frame interconnected with crisscrossing struts. (Photograph by author)
Roof Framing Typology Survey Form

80 Broad Street
City Hall

Date of Survey: 10/5/2012
Conducted By: Pam Kendrick, Carter Hudgins, Carl Lounsbury, Willie Graham

Building Information
Exterior Building Width: 60'0"
Date of Construction: 1801
Architect: Gabriel Manigault
Exterior Building Length: 75'7"
Date of Roof Framing: Post-1886
Builder: Unknown

Roof Framing Information
Roof Type: Warren Truss variation
Internal Bearing Walls
Roof Pitch: Unknown
Presence of Ridgeboard
Roof Covering: Slate
Presence of Metal Strapping
Notes: Roof replaced in the late 19th century

Selected Images

A cross section through the attic at City Hall. (Drawing from the Historic American Building Survey collection, www.loc.gov)

At the convergence of two diagonal timber struts vertical iron rods serve the structural function of a king post. (Photograph by author)
53 Meeting Street
First Scots Presbyterian Church

Date of Survey: 10/5/2012
Conducted By: Pam Kendrick, Carter Hudgins, Carl Lounsbury, Willie Graham

Building Information
Exterior Building Width: 70'0"
Exterior Building Length: 103’8"
Date of Construction: 1813
Date of Roof Framing: 1813
Architect: Unknown
Builder: Unknown

Roof Framing Information
Roof Type: King and Queen Post Combination
Roof Pitch: Unknown
Roof Covering: Unknown
Internal Bearing Walls [ ]
Presence of Ridgeboard [✓]
Presence of Metal Strapping [✓]

Notes:

Selected Images

A king post is centered on the raised tie beam. Two secondary posts provide additional support to the tie beam.
(Photograph by Willie Graham, Colonial Williamsburg Foundation)

A bent timber is bolted to the principal rafter and the raised tie beam to secure the connection between the two members.
(Photograph by Willie Graham, Colonial Williamsburg Foundation)
Roof Framing Typology Survey Form

27 King Street
Miles Brewton House

Date of Survey: 12/17/2012
Conducted By: Pam Kendrick, Liz Shaw

Building Information
Exterior Building Width: 46'9"
Exterior Building Length: 50'7"
Date of Construction: 1766
Date of Roof Framing: 1765
Architect: Unknown
Builder: Unknown

Roof Framing Information
Roof Type: Queen Post Truss Variation
Roof Pitch: Unknown
Roof Covering: Slate Tile
Internal Bearing Walls: ✓
Presence of Ridgeboard: ❌
Presence of Metal Strapping: ❌
Notes: Addition added in 1830s. A large dropped ridgeboard is visible but not accessible.

Selected Images

Angled Struts are mortise-and-tenoned into the collar tie and double pegged. (Photograph by author)

Queen post with strut mortise-and-tenoned into the joggle and secured with a single peg. Carpenters marks match the strut to the queen post. (Photograph by author)
# Roof Framing Typology Survey Form

85 Calhoun Street  
Arch Building

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## Building Information

- **Exterior Building Width:** 34'3"  
- **Exterior Building Length:** 42'5"
- **Date of Survey:** 11/2/2012

## Roof Framing Information

- **Roof Type:** Common Rafter  
- **Internal Bearing Walls:** ✓  
- **Roof Pitch:** Unknown  
- **Presence of Ridgeboard:** □  
- **Roof Covering:** Slate  
- **Presence of Metal Strapping:** ✓  
- **Notes:** Original roof framing members replaced in the 1970s with modern wood framing members.

## Selected Images

- **Modern 2x4 knee walls support modern common rafters.** (Photograph by author)
- **Collar ties span between the modern common rafters. The joint connection is strengthen with modern steel plates.** (Photograph by author)
14 George Street
Middleton-Pinckney House

Date of Survey: 11/26/2012
Conducted By: Pam Kendrick, Logan Kendrick

Building Information
Exterior Building Width: 32'3"
Exterior Building Length: 78'6"
Date of Construction: 1796
Date of Roof Framing: 1796
Architect: Unknown
Builder: Unknown

Roof Framing Information
Roof Type: King and Queen Post Combination
Roof Pitch: 46 Degrees
Roof Covering: Slate Tile
Internal Bearing Walls
Presence of Ridgeboard
Presence of Metal Strapping

Notes: The truss frame is supported by a short principal rafter tenoned into the queen post and a long principal rafter that runs on top of the short principal rafter to the joggle at the head of the king post.

Selected Images

A king post is mortised-and-tenoned to the collar tie and secured with a metal bolt. The king post tapers to a head with joggles that receive the principal rafters. (Photograph by author)
The connection between the queen post, the short principal rafter, the collar tie, and the long principal rafter is obscured by the addition of a modern metal plate. (Photograph by author)
Roof Framing Typology Survey Form

72 Meeting Street
South Carolina Society Hall

Date of Survey: 1/15/2013
Conducted By: Pam Kendrick, Charlotte

Building Information
Exterior Building Width: 58'5"
Exterior Building Length: 85'8"
Date of Construction: 1804
Date of Roof Framing: 1804
Architect: Gabriel Manigault
Builder: Unknown

Roof Framing Information
Roof Type: King Post
Internal Bearing Walls ✔
Roof Pitch: Unknown
Presence of Ridgeboard ✔
Roof Covering: Slate
Presence of Metal Strapping ✔
Notes: Raised tie beam truss design spans the length of the ballroom rather than the width of the building as is common practice.

Selected Images

Connection between the Principal Rafters, the raised tie beam, and the secondary posts are secured with metal strapping and iron bolts. (Photograph by author)

A unique, curved iron strap is used to secure the diagonal struts in place at the top of the king post where they are mortised-and-tenoned into the joggles. (Photograph by author)
Roof Framing Typology Survey Form

350 Meeting Street
Joseph-Manigault House

Date of Survey: 11/12/2012
Conducted By: Pam Kendrick, Liz Shaw, Laurel Bartlett

Building Information
Exterior Building Width: 28'0"
Exterior Building Length: 61'
Date of Construction: 1803
Date of Roof Framing: 1803
Architect: Gabriel Manigault
Builder: Unknown

Roof Framing Information
Roof Type: King and Queen Post Combination
Roof Pitch: 43 Degrees
Roof Covering: Slate
Internal Bearing Walls: ☑
Presence of Ridgeboard: ☑
Presence of Metal Strapping: ☐
Notes: Hipped Roof with Octagonal Addition

Selected Images

The atypical design does not use struts between the king post and the principal rafters. The king post is through-tenoned into the collar tie and secured with four pegs. (Photograph by author)

Base of the queen post with the strut mortise and tenoned into the joggle and secured with a single peg. Carpenters marks are present that match the strut to the queen post. (Photograph by author)
Roof Framing Typology Survey Form

4 Courthouse Square
Blake Tenements

Date of Survey: 1/16/2013
Conducted By: Pam Kendrick, Laurel Bartlett

Building Information
Exterior Building Width: 48'7"
Exterior Building Length: 43'4-1/2
Date of Construction: 1766
Date of Roof Framing: 1766
Architect: Unknown
Builder: Unknown

Roof Framing Information
Roof Type: King Post
Roof Pitch: 30 degrees
Roof Covering: Slate
Internal Bearing Walls ✔
Presence of Ridgeboard ✔
Presence of Metal Strapping ✔

Notes: Hipped Roof features two king post truss frames. A pit sawn partition wall survives that divides the attic space in half longitudinally.

Selected Images

A beam spans between the king posts approximately 12 inches below the apex of the roof. Score marks on the ridge board align with the placement of the common rafters. (Photograph by author)

The base of the king post is strapped to the tie beam with metal U-straps and secured with a single iron bolt. Joggles on the base of the post receive inclined struts. (Photograph by author)
Roof Framing Typology Survey Form

38 Elizabeth Street
Aiken-Rhett House

Date of Survey: 1/16/2013
Conducted By: Pam Kendrick, Liz Shaw

**Building Information**

<table>
<thead>
<tr>
<th>Exterior Building Width:</th>
<th>22'8&quot;</th>
<th>Exterior Building Length:</th>
<th>54'6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Construction:</td>
<td>1818</td>
<td>Date of Roof Framing:</td>
<td>1818</td>
</tr>
<tr>
<td>Architect:</td>
<td>Unknown</td>
<td>Builder:</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

**Roof Framing Information**

<table>
<thead>
<tr>
<th>Roof Type:</th>
<th>Common Rafter</th>
<th>Internal Bearing Walls</th>
<th>☑</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Pitch:</td>
<td>45 Degrees</td>
<td>Presence of Ridgeboard</td>
<td>☐</td>
</tr>
<tr>
<td>Roof Covering:</td>
<td>Slate</td>
<td>Presence of Metal Strapping</td>
<td>☐</td>
</tr>
<tr>
<td>Notes:</td>
<td>Common rafter hipped roof. Collar ties span between each rafter pair.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Selected Images**

Collar ties span between each pair of common rafters. The collar ties are mortised-and-tenoned into each collar tie and secured with a single peg. (Photograph by author)

Common rafter pairs are mortised-and-tenoned together and secured with a single peg at the roof ridge. (Photograph by author)
Roof Framing Typology Survey Form

100 Meeting Street
Fireproof Building

Date of Survey: 1/18/2013
Conducted By: Pam Kendrick, Neale Nickels

Building Information

Exterior Building Length: 66'5"
Exterior Building Width: 56'9"
Date of Construction: 1827
Date of Roof Framing: 1827
Architect: Robert Mills
Builder: John G. Spindle

Roof Framing Information

Roof Type: Common Rafter
Roof Pitch: Unknown
Roof Covering: Slate
Internal Bearing Walls
Presence of Ridgeboard
Presence of Metal Strapping
Notes: Scissor bracing supports the dome ceiling. Common rafters form the roof frame.

Selected Images

Plans of the third floor and the roof show the location of the internal load bearing walls on the third floor that provide support to the roof frame. (Historic American Building Survey, www.loc.gov)
The central stairwell raises two stories tall. A dome ceiling caps the stairwell. (Historic American Building Survey collections, www.loc.gov)
51 Meeting Street  
Nathaniel Russell House

Date of Survey: 1/17/2013  
Conducted By: Pam Kendrick, Laurel Bartlett

**Building Information**

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Construction: 1808</td>
<td>Date of Roof Framing: 1808</td>
</tr>
<tr>
<td>Architect: Unknown</td>
<td>Builder: Unknown</td>
</tr>
</tbody>
</table>

**Roof Framing Information**

<table>
<thead>
<tr>
<th>Roof Type: King and Queen Post Combinati</th>
<th>Internal Bearing Walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Pitch:</td>
<td>Presence of Ridgeboard</td>
</tr>
<tr>
<td>Roof Covering: slate</td>
<td>Presence of Metal Strapping</td>
</tr>
<tr>
<td>Notes: Building width excludes octagonal wing. A visible but unaccessible ridgeboard spans between king posts and provides a connection point for the common rafters.</td>
<td></td>
</tr>
</tbody>
</table>

**Selected Images**

- Joggles cut into the base of the queen post receive inclined struts that extend to the principal rafters. The bottom portion of the queen post is obscured by the installation of finished flooring. Photograph by author.
- Common rafters are butted and nailed to a false plate at the feet and the hip rafters and the head. Photograph by author.
Roof Framing Typology Survey Form

76 East Bay Street
Vanderhorst Row

Date of Survey: N/A
Conducted By: N/A

Building Information
Exterior Building Width: 50'10"  Exterior Building Length: 82'0"
Date of Construction: 1800  Date of Roof Framing: 1800
Architect: Unknown  Builder: Unknown

Roof Framing Information
Roof Type: King and Queen Post Combinati  Internal Bearing Walls
Roof Pitch: Unknown  Presence of Ridgeboard
Roof Covering: Slate  Presence of Metal Strapping
Notes: Data and Drawings completed by Willie Graham of Colonial Williamsburg Foundation and students from the ICOMOS internship program. (Drawings provided by Historic Charleston Foundation)

Selected Images

A section cut through the attic of Vanderhorst Row reveals a king-and-queen post truss. (Drawing provided by Historic Charleston Foundation archives)

A plan view of the attic floor indicates the location of the truss sets in relation to one another. (Drawing provided by Historic Charleston Foundation archives)
Roof Framing Typology Survey Form

10 Judith Street
John Robinson House

Date of Survey:                      Conducted By:  N/A

Building Information
Exterior Building Width: 38'2"  Exterior Building Length: 53'2"
Date of Construction: 1814  Date of Roof Framing: 1814
Architect: Unknown  Builder: Unknown

Roof Framing Information
Roof Type: Common Rafter  Internal Bearing Walls ☑
Roof Pitch: Unknown  Presence of Ridgeboard ☐
Roof Covering: Slate Tile  Presence of Metal Strapping ☐
Notes: Common rafter roof with hipped ends.

Selected Images

Common rafter pairs are mortised-and-tenoned together at the apex and secured with a wooden peg. (Photograph provided by David Elders)
Purlins are through-tenoned into the principal rafters and pegged. (Photograph provided by David Elders)
Roof Framing Typology Survey Form

84 Broad Street
Courthouse

Date of Survey: 1/24/2013
Conducted By: Pam Kendrick, Carter Hudgins

Building Information
Exterior Building Width: 54’6”
Exterior Building Length: 105’8”
Date of Construction: 1792
Date of Roof Framing: 1792
Architect: James Hoban
Builder: Unknown

Roof Framing Information
Roof Type: Queen Post
Roof Pitch: Unknown
Roof Covering: Slate
Notes: Hipped roof form. Some timber frame members show signs of an earlier fire in the attic. Modern steel has been inserted to provide additional support to the historic roof frame.

Internal Bearing Walls
Presence of Ridgeboard
Presence of Metal Strapping

Selected Images

Queen post joggle with carpenters marks. Strut is mortise-and-tenoned and single pegged into the joggle. (Photograph by author)

Struts above the collar tie are mortised-and-tenoned into the principal rafters and single pegged. (Photograph by author)
Roof Framing Typology Survey Form

47 East Bay Street
George Sommers House

Date of Survey: 1/31/2013
Conducted By: Pamela Kendrick, Willie Graham, Carter Hudgins, Richard Marks

Building Information
Exterior Building Width: 25'1"
Exterior Building Length: 91'10"
Date of Construction: 1740
Date of Roof Framing: 1740
Architect: Unknown
Builder: Unknown

Roof Framing Information
Roof Type: Common Rafter
Roof Pitch: Unknown
Roof Covering: Slate
Internal Bearing Walls ☑
Presence of Ridgeboard ☐
Presence of Metal Strapping ☐

Notes: Original roof had hipped ends. In the mid-nineteenth century the hipped ends were replaced with gabled ends. The original common rafters are distinguishable from the more modern rafters.

Selected Images

Half lapped dovetail joints between the common rafters and the collar ties. (Photograph by author)
A mortise-and-tenon joint secured with a wooden peg connects a common collar tie to the common rafter. (Photograph by author)
Goose Creek
Mulberry Plantation

Date of Survey: 2/1/2013
Conducted By: Pam Kendrick, Willie Graham, Richard Marks

Building Information
Exterior Building Length: 46'2"
Exterior Building Width: 29'4"
Date of Construction: 1714
Date of Roof Framing: 1810
Architect: Unknown
Builder: Unknown

Roof Framing Information
Roof Type: King Post Variation
Roof Pitch: Unknown
Roof Covering: Slate
Internal Bearing Walls
Presence of Ridgeboard
Presence of Metal Strapping

Notes: Gambrel roof likely constructed in the late eighteenth century. The roof frame uses a modified king post and vertical struts to support the tie beams. Common rafters form the upper portion of the roof.

Selected Images
The lower half of the gambrel roof contains a modified king post truss with vertical struts that support the tie beams. (Photograph by author)
Where the roof angle changes a large purlin provides a connection point between the common rafters for the lower roof and the common rafters for the upper roof. (Photograph by author)
Roof Framing Typology Survey Form

6 Archdale Street
Unitarian Church

Date of Survey: 1/13/2013
Conducted By: Pam Kendrick, Willie Graham, Glenn Keyes, Richard Marks, Carter Hudgins

**Building Information**

<table>
<thead>
<tr>
<th>Exterior Building Width: 47'7&quot;</th>
<th>Exterior Building Length: 105'4&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Construction: 1852</td>
<td>Date of Roof Framing: 1852</td>
</tr>
<tr>
<td>Architect: Francis D. Lee</td>
<td>Builder: Unknown</td>
</tr>
</tbody>
</table>

**Roof Framing Information**

<table>
<thead>
<tr>
<th>Roof Type: Queen Post</th>
<th>Internal Bearing Walls:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Pitch: Unknown</td>
<td>Presence of Ridgeboard:</td>
</tr>
<tr>
<td>Roof Covering: Standing seam tin</td>
<td>Presence of Metal Strapping:</td>
</tr>
<tr>
<td>Notes: Iron rods provide support between the tie beam and the principal rafters</td>
<td></td>
</tr>
</tbody>
</table>

**Selected Images**

Collar tie connection with the queen post and the principal rafter. Metal bolts secure the mortised-and-tenoned joints. (Photograph by author)

Connection point between the principal rafter and the tie beam at the wall plate is secured with metal straps that are bolted together. (Photograph by author)
80 Meeting Street
St Michaels Church

Date of Survey: 1/24/2013
Conducted By: Pamela Kendrick, Laurel Bartlett

**Building Information**

- Exterior Building Width: 65'9"
- Exterior Building Length: 112'6"
- Date of Construction: 1761
- Date of Roof Framing: 1761
- Architect: Unknown
- Builder: Sam Cardy

**Roof Framing Information**

- Roof Type: King and Queen Post Combinati
- Roof Pitch: Unknown
- Roof Covering: Slate
- Internal Bearing Walls
- Presence of Ridgeboard: ✓
- Presence of Metal Strapping: ✓

**Notes:**
The ridgeboard and several common rafters are modern wood timbers. It is unclear whether a ridgeboard was included in the original construction or if it was added during modern repairs.

**Selected Images**

- Spacing of the truss systems in the St. Michael’s attic. (Photograph by author)
- The queen post is tied to the principal rafter using metal strapping. (Photograph by author)
Roof Framing Typology Survey Form

6 Glebe Street
Bishop Robert Smith House

Date of Survey: N/A
Conducted By: N/A

Building Information

- Exterior Building Width: 47'5"
- Exterior Building Length: 52'3"
- Date of Construction: 1770
- Date of Roof Framing: 1770
- Architect: Unknown
- Builder: Unknown

Roof Framing Information

- Roof Type: King Post Truss
- Internal Bearing Walls: [ ]
- Roof Pitch: Unknown
- Presence of Ridgeboard: [ ]
- Roof Covering: Slate
- Presence of Metal Strapping: [ ]
- Notes: Information provided is derived from HABS drawings completed by Robert Busser.

Selected Images

- Partial section cut showing a king post truss roof system. (Provided by Historic American Building Survey collection, www.loc.gov)
- A close up of the section cut reveals a king post truss roof system with possible secondary truss posts. (Photograph provided by Historic American Building Survey collection, www.loc.gov)
Roof Framing Typology Survey Form

126 Coming Street
Cathedral of St Lukes and St Pauls

Date of Survey: 10/1/2012
Conducted By: Wendy Madill, Craig Bennett, Pam Kendrick

Building Information
Exterior Building Width: 77'5"
Exterior Building Length: 96'10"
Date of Construction: 1814
Date of Roof Framing: 1814
Architect: Unknown
Builder: Unknown

Roof Framing Information
Roof Type: King Post Truss
Roof Pitch: Unknown
Roof Covering: Slate
Internal Bearing Walls
Presence of Ridgeboard
Presence of Metal Strapping

Notes: King post truss with two secondary supports. The exterior walls rise to the height of the vaulted ceiling to accommodate the protruding vaulted ceiling.

Selected Images

The two-story church nave contains a vaulted ceiling that is supported by a king post truss with secondary posts. (Photograph by author)
The secondary truss posts tie to the principal rafters through a series of struts. Inclined struts brace the secondary posts against the joggle of the king post base. (Photograph by Wendy Madill)
Roof Framing Typology Survey Form

39 Church Street
George Eveleigh House

Date of Survey: N/A
Conducted By: N/A

Building Information

| Exterior Building Width: 34'2" | Exterior Building Length: 39'10" |
| Date of Construction: 1745 | Date of Roof Framing: 1745 |
| Architect: Unknown | Builder: Unknown |

Roof Framing Information

| Roof Type: Principal Rafter | Internal Bearing Walls | ☑ |
| Roof Pitch: Unknown | Presence of Ridgeboard | ☐ |
| Roof Covering: Slate | Presence of Metal Strapping | ☐ |

Notes: Photographs provided of 39 Church Street by Richard Marks and Glenn Keyes. Access was not obtained for this study and therefore, information provided is derived from photographs and oral interviews.

Selected Images

Collar ties are joined to the principal rafters on each side with a dovetail joint and secured with a single peg. (Photograph by Glenn Keyes, Glenn Keyes Architects)

Scissor bracing supports the vaulted ceiling for the ballroom below. (Photograph provided by Glenn Keyes, Glenn Keyes Architects)
**Roof Framing Typology Survey Form**

**McClellanville, SC**

**Hampton Plantation**

<table>
<thead>
<tr>
<th>Exterior Building Width:</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Construction:</td>
<td>1735</td>
</tr>
<tr>
<td>Architect:</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

| Exterior Building Length: | Unknown |
| Date of Roof Framing:    | Unknown |
| Builder:                 | Unknown |

| Roof Type:               | Principal Rafter |
| Roof Pitch:              | Unknown          |
| Roof Covering:           | Slate            |
| Notes:                   | Hipped roof replaced the original roof during one of many building campaigns. The roof likely was built in the late eighteenth century. |

The hipped ends are created with principal rafters, hipped rafters, and common rafters nailed together. A ridgeboard runs the length of the building. (Photograph by author)

Vertical struts form a small knee wall below the common rafters. These struts are butted and nailed to the rafters and the floor joists. (Photograph by author)
Roof Framing Typology Survey Form

Johns Island, SC
Fenwick Plantation

Date of Survey: 4/1/2011
Conducted By: David Weirick, Lauren Golden

Exterior Building Width: 38'6"
Exterior Building Length: 66'10"
Date of Construction: 1730
Date of Roof Framing: Unknown
Architect: Unknown
Builder: Unknown

Roof Type: M-Roof
Roof Pitch: Unknown
Roof Covering: Slate
Notes: M-roof consists of original and replaced wood timbers.

Internal Bearing Walls [✓]
Presence of Ridgeboard [☐]
Presence of Metal Strapping [☐]

The roof framing members meet at a central valley in the center of the building which forms an internal gutter. (Photograph by David Weirick and Lauren Golden)

Common rafters are mortised-and-tenoned together at the apex and secured with wooden pegs. (Photograph by David Weirick and Lauren Golden)
<table>
<thead>
<tr>
<th>Framing Member</th>
<th>Dimensions</th>
<th>Wood Species</th>
<th>Material Preparation</th>
<th>Joinery</th>
<th>Spacing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girder</td>
<td>3 ¾” x 8”</td>
<td>Cypress?</td>
<td>Pit Sawn &amp; Planed</td>
<td>Tusk tenoned and single pegged</td>
<td></td>
<td>Girt flanks king post</td>
</tr>
<tr>
<td>Joists</td>
<td>3” x 7 ¾”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn, Planed</td>
<td>Tusk tenoned and pinned</td>
<td>1’8” o/c</td>
<td>Roman numerals present on common joists</td>
</tr>
<tr>
<td>Outrigger Joists</td>
<td>3” x 7”</td>
<td>Pine</td>
<td>Hewn &amp; Pit Sawn</td>
<td>Through tenoned and wedged</td>
<td>1’9” o/c</td>
<td></td>
</tr>
<tr>
<td>King Post</td>
<td>6 ¾” x 1’1 ½”</td>
<td>Pine</td>
<td>Pit Sawn, Planed, Adzed</td>
<td>Tenoned and double pegged, strapped to tie beam</td>
<td>6’8” o/c</td>
<td>Fixed to a truncated tie beam with an iron U-strap, trusses placed to catch hip rafters</td>
</tr>
<tr>
<td>King Post Struts</td>
<td>5” x 5 ½”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Tenoned and single pegged</td>
<td></td>
<td>Strut not centered on king post joggle</td>
</tr>
<tr>
<td>Principal Rafter</td>
<td>6 ¼” x 9”</td>
<td>Pine</td>
<td>Hewn, Adze, Planed</td>
<td>Tenoned and single pegged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Rafter</td>
<td>3 ½” x 5 ½”</td>
<td>Pine</td>
<td>Hewn &amp; Pit Sawn</td>
<td>Butt and nailed to false plate</td>
<td>1’8” o/c</td>
<td>Lapped over purlins, tenon and single pegged into ridgeboard at center bay.</td>
</tr>
<tr>
<td>Purlins</td>
<td>Varies</td>
<td>Pine</td>
<td>Adzed, Pit Sawn</td>
<td>Through tenoned and double pegged</td>
<td></td>
<td>Staggard, set flush with bottom of principal rafters</td>
</tr>
<tr>
<td>Truss Tie Beam</td>
<td>8” x 8 ½”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Through tenoned and wedged</td>
<td></td>
<td>Truncated by perimeter plate</td>
</tr>
<tr>
<td>Perimeter Plate</td>
<td>3 ¾” x 7”</td>
<td>Pine</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Tenoned and single pegged</td>
<td></td>
<td>Provides outrigger joists with a connection point</td>
</tr>
<tr>
<td>False Plate</td>
<td>9 ½” x 1 ½”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Sits on top of outrigger joists</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truncated Tie Beam</td>
<td>5 ½” x 7 ½”</td>
<td>Pine</td>
<td>Hand planed</td>
<td>Through tenoned and wedged</td>
<td>1’8” between bearing plates</td>
<td></td>
</tr>
<tr>
<td>Hip Rafters</td>
<td>6” x 9”</td>
<td>Pine</td>
<td>Pit Sawn, Planed</td>
<td>Tenoned and double pegged, strapped</td>
<td></td>
<td>Double beveled crown on top</td>
</tr>
<tr>
<td>Jack Rafter</td>
<td>3 ½” x 5 ½”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Butt and double nailed</td>
<td></td>
<td>Truncated by hip rafter</td>
</tr>
<tr>
<td>Hip Principle</td>
<td>5 ½” x 10”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Butt and spiked to RP, tenoned and double pegged with strap to truncated tie beam</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Framing Schedule compiled by Pamela Kendrick

October 4, 2012
## St. Michael’s Church, c. 1751
80 Meeting Street, Charleston, SC

<table>
<thead>
<tr>
<th>Framing Member</th>
<th>Dimensions</th>
<th>Wood Species</th>
<th>Material Preparation</th>
<th>Joinery</th>
<th>Spacing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tie beam</td>
<td>7 ⅝&quot; x 11 ¼&quot;</td>
<td>Pine</td>
<td>Pit Sawn, Planed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queen Posts</td>
<td>8 ¼&quot; x 8 ½&quot;</td>
<td>Pine</td>
<td>Hewn, Pit Sawn, Planed</td>
<td>Tenoned and double pegged, strapped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queen Post Struts</td>
<td>6 ½&quot; x 6&quot;</td>
<td>Pine</td>
<td>Hewn &amp; Pit Sawn</td>
<td>Tenoned and double pegged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collar Tie</td>
<td>8 ½&quot; x 10&quot;</td>
<td>Pine</td>
<td>Pit Sawn &amp; Adzed</td>
<td>Tenoned and double pegged</td>
<td></td>
<td>Adzed on the bottom face</td>
</tr>
<tr>
<td>Principal Rafter</td>
<td>8&quot; x 10&quot;</td>
<td>Pine</td>
<td>Hewn</td>
<td>Tenoned and single pegged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Rafter</td>
<td>2&quot; x 6 ¼&quot;</td>
<td>Pine</td>
<td>Sash sawn</td>
<td>Butt and nailed to wall plate</td>
<td>19” o/c</td>
<td>Butt and nailed to modern ridgeboard</td>
</tr>
<tr>
<td>Purlin</td>
<td>7&quot; x 8 ¼&quot;</td>
<td>Pine</td>
<td>Hewn &amp; Pit Sawn</td>
<td>Through tenoned and wedged</td>
<td></td>
<td>Three sets of purlins</td>
</tr>
<tr>
<td>Floor Joists</td>
<td>2&quot; x 2 ½&quot;</td>
<td>Pine</td>
<td>Adzed, Pit Sawn</td>
<td>Tenoned and single pegged</td>
<td>14” o/c</td>
<td></td>
</tr>
</tbody>
</table>

Framing Schedule compiled by Pamela Kendrick  
January 24, 2013
### Courthouse, c. 1796
85 Broad Street, Charleston, SC

<table>
<thead>
<tr>
<th>Framing Member</th>
<th>Dimensions</th>
<th>Wood Species</th>
<th>Material Preparation</th>
<th>Joinery</th>
<th>Spacing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tie Beam</td>
<td>8 ½” x 10”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Strapped to Principal Rafter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girder</td>
<td>8 ½” x 10”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn, Planed</td>
<td>Tenoned and pegged to tie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queen Post</td>
<td>8 ½” x 10”</td>
<td>Pine</td>
<td>Hewn &amp; Pit Sawn</td>
<td>Tenoned and double pegged, strapped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queen Post Struts</td>
<td>5 ¾” x 8 ½”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Tenoned and double pegged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal Rafter</td>
<td>8 ½” x 10”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Tenoned and pegged, strapped to tie beam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Rafter</td>
<td>3” x 5 ¾”</td>
<td>Pine</td>
<td>Adzed</td>
<td>Tenoned and pegged</td>
<td>1’6” o/c</td>
<td>No ridgeboard present</td>
</tr>
<tr>
<td>Purlins</td>
<td>6 ¼” x 10 ½”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Tenoned into principal rafter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Joist</td>
<td>2 ¾” x 10”</td>
<td>Pine</td>
<td>Adzed, Pit Sawn</td>
<td>Tenoned and single pegged</td>
<td>1’7 ½” o/c</td>
<td></td>
</tr>
<tr>
<td>Principal Rafter Brace</td>
<td>5 ¾” x 8 ½”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Tenoned and strapped to tie beam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip Rafter</td>
<td>5 ½” x 10”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collar Tie</td>
<td>8 ½” x 6 ¾”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Tenoned and pegged to queen post</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Struts above collar</td>
<td>6 ¼” x 8 ½”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Tenoned and single pegged to principal rafters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Framing Schedule compiled by Pamela Kendrick
January 24, 2013
### Nathaniel Russell House, c. 1808
51 Meeting Street, Charleston, SC

<table>
<thead>
<tr>
<th>Framing Member</th>
<th>Dimensions</th>
<th>Wood Species</th>
<th>Material Preparation</th>
<th>Joinery</th>
<th>Spacing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tie Beam</td>
<td>10” x ??</td>
<td>Pine</td>
<td>Planed</td>
<td></td>
<td></td>
<td>Tie beam depth is obscured by finished flooring</td>
</tr>
<tr>
<td>Principal Rafters</td>
<td>3 ½” x 10½”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Tenoned and double pegged</td>
<td></td>
<td>Spacing between principal rafter and sheathing is 7”</td>
</tr>
<tr>
<td>Common Rafters</td>
<td>2 ¾” x 3 ¾”</td>
<td>Pine</td>
<td>Sash Sawn</td>
<td>Butt and nailed to ridgeboard</td>
<td>1’2” o/c</td>
<td></td>
</tr>
<tr>
<td>Queen Post</td>
<td>7 ¼” x 8”</td>
<td>Pine</td>
<td>Pit Sawn, Planed</td>
<td>Tenoned and double pegged</td>
<td></td>
<td>Base of queen post is obscured by finished flooring</td>
</tr>
<tr>
<td>Queen Post Struts</td>
<td>3 ¼” x 4 ¼”</td>
<td>Pine</td>
<td>Pit Sawn</td>
<td>Tenoned and single pegged to principal rafter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collar Tie</td>
<td>3½” x 11 ½”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Tenoned and double pegged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>King Post</td>
<td>3 ½” x 11 ½”</td>
<td>Pine</td>
<td>Planed</td>
<td>Through tenoned and double pegged</td>
<td></td>
<td>King post tapers to a diamond-shaped head</td>
</tr>
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</table>

Framing Schedule compiled by Pamela Kendrick
January 17, 2013
### Framing Schedule

**Middleton-Pinckney House, c. 1796**  
14 George Street, Charleston, SC

<table>
<thead>
<tr>
<th>Framing Member</th>
<th>Dimensions</th>
<th>Wood Species</th>
<th>Material Preparation</th>
<th>Joinery</th>
<th>Spacing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tie Beam</td>
<td>??</td>
<td>??</td>
<td>??</td>
<td>??</td>
<td>??</td>
<td>Obscured by finished flooring</td>
</tr>
<tr>
<td>Long Principal Rafters</td>
<td>3 ½” x 9 ¾”</td>
<td>Pine</td>
<td>Pit Sawn, Planed</td>
<td>Tenoned and single pegged to king post joggle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Principal Rafters</td>
<td>5 ¾” x 6 ½”</td>
<td>Pine</td>
<td>Pit Sawn, Planed</td>
<td>Tenoned and single pegged</td>
<td></td>
<td>Common rafters taper at the roof ridge</td>
</tr>
<tr>
<td>Common Rafters</td>
<td>3” x 7’</td>
<td>Pine</td>
<td>Pit Sawn, Sash sawn, Planed</td>
<td>Butt and nailed to ridgeboard</td>
<td>1’5 ½” o/c</td>
<td>Common rafters taper at the roof ridge</td>
</tr>
<tr>
<td>Queen Post</td>
<td>3¾” x 7 ¾”</td>
<td>Pine</td>
<td>Planed</td>
<td>Tenoned and pegged</td>
<td></td>
<td>Obscured by finished flooring</td>
</tr>
<tr>
<td>Queen Post Struts</td>
<td>3 ¼” x 8”</td>
<td>Pine</td>
<td>Hewn, Pit Sawn</td>
<td>Tenoned and pegged</td>
<td></td>
<td>Connection obscured by metal plates</td>
</tr>
<tr>
<td>King Post</td>
<td>7 ½” x 11 ¾”</td>
<td>Pine</td>
<td>Planed</td>
<td>Through tenoned, pegged, and wedged</td>
<td></td>
<td>King post tapers to a diamond-shaped head</td>
</tr>
<tr>
<td>Collar Tie</td>
<td>3⅞” x 7 ¾”</td>
<td>Pine</td>
<td>Pit Sawn, Planed</td>
<td>Tenoned and pegged</td>
<td></td>
<td>Connection obscured by metal plates</td>
</tr>
</tbody>
</table>

Framing Schedule compiled by Pamela Kendrick  
November 26, 2012
<table>
<thead>
<tr>
<th>Framing Member</th>
<th>Dimensions</th>
<th>Wood Species</th>
<th>Material Preparation</th>
<th>Joinery</th>
<th>Spacing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tie Beam</td>
<td>3 1/2&quot; x 10 1/2&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Set in Brick Wall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joists</td>
<td>5&quot; x 10&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Set in Brick Wall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queen Posts</td>
<td>5&quot; x 8&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Tenon &amp; pinned to tie beam &amp; rafters</td>
<td></td>
<td>Tapers to 5&quot; x 6&quot; above the joggle</td>
</tr>
<tr>
<td>Queen Post Struts</td>
<td>5&quot; x 6 1/4&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Tenoned &amp; pegged to QP &amp; PR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Queen Post Straining Beam</td>
<td>5 1/4&quot; x 8&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Tenoned &amp; shouldered onto QP, double pegged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>King Post</td>
<td>5&quot; x 10&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Tenoned &amp; double pegged, bottom</td>
<td></td>
<td>Tapers to 5&quot; x 6 1/4&quot; at ridge</td>
</tr>
<tr>
<td>King Post Struts</td>
<td>5&quot; x 5&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Tenoned &amp; pegged to KP &amp; PR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal Rafters</td>
<td>5&quot; x9 &quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Tenoned &amp; double pegged to KP, QP straining beam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purlins</td>
<td>4&quot; x 6&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Shouldered tenon &amp; pegged to PR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Rafters</td>
<td>3&quot; x 5&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Open mortise &amp; tenon &amp; pegged top</td>
<td></td>
<td>Lap over purlins, single length from eaves to ridge</td>
</tr>
<tr>
<td>False Plate?</td>
<td>??</td>
<td>SYP</td>
<td>??</td>
<td>??</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pediment Rafters</td>
<td>2 3/4&quot; x 6 1/2&quot;</td>
<td>SYP</td>
<td>Hewn &amp; Sash Sawn</td>
<td>Open mortise &amp; tenon top; nailed to sheathing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Framing Schedule compiled by Willie Graham, Colonial Williamsburg Foundation
11-Jun-96
APPENDIX D

3-DIMENSIONAL MODELS
Figure D.1: A model depicting the common rafter roof at 47 East Bay Street, Charleston, SC. Common rafters shown in blue are original to the roof. The common rafters shown in white were added when the hipped roof was converted to a gable roof. (Drawing by author)
Figure D.2: A section cut depicting a common rafter pair at 47 East Bay Street that is mortised-and-tenoned and pegged together at the ridge. The collar tie is mortised-and-tenoned into the common rafters and secured with a peg. (Drawing by author)
Figure D.3: A section cut depicting a common rafter pair at 47 East Bay Street that is mortised-and-tenoned and pegged together at the ridge. The collar tie is joined to the common rafters with a half lapped dovetailed joint and secured with two nails. (Drawing by author)
Figure D.4: A Model depicting the king post truss roof at the Heyward Washington House, Charleston, SC. Rafter members have been removed from the drawing in order to highlight the critical components such as the king post trusses, the dropped ridge board, and the unique floor framing composition. (Drawing by author)
Figure D.5: A close up of the king post truss locations in relation to the tie beams. The truncated tie beams are tied to girders which then connect to the tie beams. The principal rafters are in line with the king posts and therefore rest on truncated tie beams as well. (Drawing by author)
REFERENCES


