



**SOUTHERN**  
staircase™

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Custom Curved  
Staircase Construction:

**CHALLENGES AND SOLUTIONS  
FROM SOUTHERN STAIRCASE**

# EXECUTIVE SUMMARY

This whitepaper explores the intricate craft and advanced engineering required to create [custom curved staircases](#). The construction of a curved staircase demands extensive detail, combining traditional craftsmanship with modern technology.

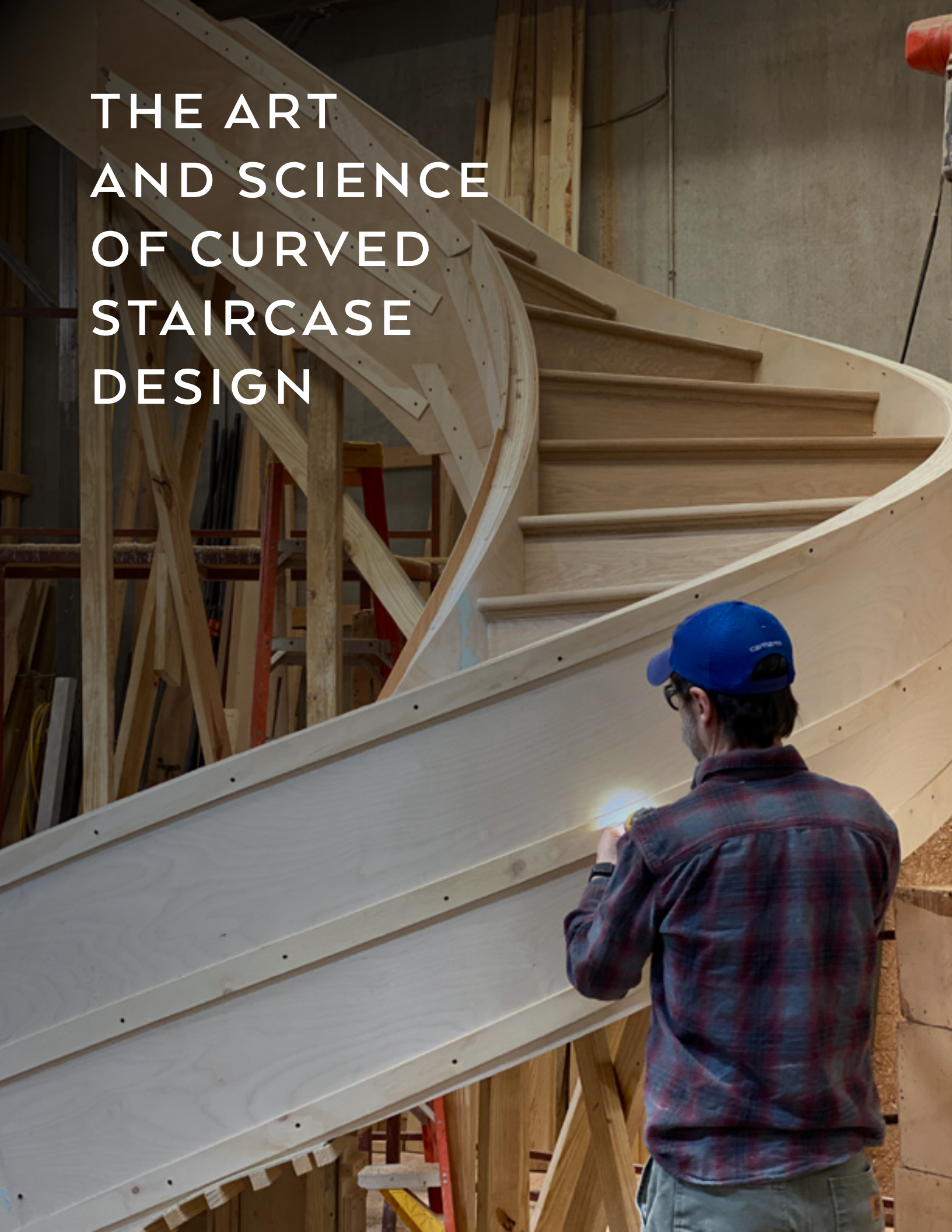
[Custom stair designs](#) are uniquely challenging, especially a custom curve stair. Each curved staircase requires specialized engineering factoring live load calculations, lateral loads, deflection, material selection, and compliance with building codes.

[Southern Staircase](#) is dedicated to pushing the limits of design, where advanced technology complements rather than replaces the knowledge and experience passed down through generations of artisans.

For over 40 years, [Southern Staircase](#) has been setting the highest industry standards for [custom curved stair](#) construction. They invite builders, [architects](#), and industry leaders to partner with them and leverage their skills to create functional, artful curved staircases.



# THE ART AND SCIENCE OF CURVED STAIRCASE DESIGN





# THE ART AND SCIENCE OF CURVED STAIRCASE DESIGN

Designing a [custom curved staircase](#) is a delicate interplay between vision and engineering. Unlike [traditional staircases](#) with straightforward geometries, modern curved stairs necessitate careful planning, precise measurements, and a profound understanding of spatial dynamics.

[Southern Staircase](#) initiates each curved stair project with a comprehensive consultation and design process.

## THE DESIGN PROCESS

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Accurate site measurements and detailed consultations with the client are the foundations of [curved staircase construction](#). Advanced CAD software translates these measurements and ideas into detailed blueprints. This technology facilitates the simulation of curvature and slope and the integration of various design elements, including [handrails](#), balusters, and [treads](#).

## TECHNICAL CHALLENGES AND SOLUTIONS

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Creating [custom curved stairs](#) presents unique technical challenges requiring innovative solutions.

## CHALLENGES

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### Structural Integration

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Designing a curved staircase for new construction requires careful planning to ensure seamless integration. Unlike [traditional staircases](#), a curved staircase is not simply attached to the structure—it must be engineered from the outset to fit precisely within the architectural design while maintaining durability.

### Material Selection and Fabrication

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The choice of materials profoundly impacts the staircase’s durability, style, and overall presence. Selecting suitable materials is required to achieve the stairs’ structural integrity and preferred aesthetic appeal.

### Fabrication Techniques

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[Modern curved stairs](#) demand precise precision and high-quality craftsmanship. Meticulous attention to detail must be implemented throughout the design process to achieve smooth, continuous curves.

### Lighting Integration

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While optional, integrating lighting into curved stairs poses unique design and engineering challenges. Ensuring lighting is functional and aesthetically pleasing requires careful planning and execution.

### Coordination with External Vendors

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[Curved stairs](#) construction often necessitates collaboration with external vendors, such as steel fabricators and glass suppliers. Coordinating these relationships is important for integrating high-quality materials and components into the final stair design.

## SOLUTIONS

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### Collaboration for Structural Integration

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[Southern Staircase](#) collaborates with [architects](#) and engineers to assess floor plans and load-bearing walls. They often incorporate custom steel supports and advanced anchoring techniques to ensure the curved staircase's functionality and aesthetic appeal.

### Comprehensive Material Offering

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The company offers an array of materials, including [wood](#), [steel](#), and [glass](#), crafted to the highest standards.

### Advanced Fabrication Techniques

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[Skilled artisans](#) use advanced cutting, bending, and welding techniques to ensure that every curve aligns perfectly with the CAD design.

### Seamless Lighting Integration

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While not a standard feature, LED lighting can be incorporated into stair treads, handrails, and under-stair lighting channels upon request, these systems are customized to fit the staircase's design and can be compatible with smart home integrations, including Google Home and Alexa.

### Strong Vendor Relationships and Coordination

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Southern Staircase partners exclusively with industry-leading vendors who excel in their areas of expertise. These strong relationships ensure that only the highest-quality components are used in every project, enabling the seamless integration of multiple design elements, including [glass railings](#) and custom [metalwork](#).

# ENGINEERING AND DESIGN CONSIDERATIONS





# ENGINEERING AND DESIGN CONSIDERATIONS

Building [custom curved staircases](#) is a sophisticated process that combines unique design elements with advanced technical construction. Each staircase presents a unique set of challenges that must be addressed to ensure its aesthetic appeal and structural integrity.

## STRUCTURAL STABILITY PRINCIPLES

The key aspect of [custom curved staircases](#) design is ensuring structural stability. The engineering process begins with live load calculations, which account for the weight the stairs will need to support under typical usage, including the weight of people, furniture, and other potential loads. Lateral loads, such as those caused by seismic activity or wind, are also carefully considered to maintain stability in all conditions.

Another significant factor in the design is deflection—the degree to which the staircase structure might bend under load. Each curve and angle of the staircase is designed with deflection limits in mind, ensuring that it maintains its shape and function over time without compromising safety or aesthetics. Safety factors are built into every calculation to guarantee that curved staircases meet national and local building codes.

## SOLUTIONS

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The choice of materials is paramount to custom curved staircases' design and structural integrity. Various materials, including [wood](#), [steel](#), and [glass](#), can be employed, each requiring specific engineering considerations.

### Wood

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For [wooden staircases](#), high-quality glue types and nail patterns are selected to ensure the longevity and integrity of laminated wood components. Lamination techniques, where layers of wood are bonded together, allow for greater flexibility in curve design while maintaining strength. Each piece is carefully engineered with specific beam dimensions to accommodate the expected loads. The glue types used are chosen to resist shifting over time, ensuring the long-term safety and security of the curved staircase.

Specific materials like Sepili wood are chosen for their strength, especially in intricate [curved stair designs](#) requiring higher load-bearing capacity. The wood's moisture content is considered to prevent warping or cracking over time. Plywood with veneers is typically used for the structural components, offering a balance of flexibility and strength while maintaining an aesthetically pleasing finish.

## Steel

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[Steel staircases](#) harness the material's strength and flexibility to create precise curves. The steel beams are designed with careful attention to load capacity, ensuring that they can support the structure's weight without compromising the overall aesthetic. Steel creates unique design possibilities, including integrating thinner, more streamlined beams into the design while maintaining the necessary load-bearing capacity of the curved stairs.

Depending on the project requirements, various steel types may be used, including mild steel, high-strength steel, and Hollow Structural Sections (HSS). These materials offer enhanced structural integrity and the ability to form precise curves. For [exterior applications](#), steel components are powder-coated to protect them from rust and provide additional weather resistance.

## Glass

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[Glass staircases](#) present unique engineering challenges regarding material strength and safety. The glass panels must be tempered to ensure they can support the weight of the curved staircase without cracking or breaking under pressure.

Laminated glass provides added protection, as it holds together even when cracked. Tempered glass is used in areas requiring high resistance to increased foot traffic. These types of glass are selected for each curved stair design based on specific code requirements and the staircase's intended use.

## CUSTOMIZATION IN ENGINEERING

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Each [curved staircase](#) design is unique, requiring bespoke engineering techniques based on the chosen materials and the specific design parameters. Curving a staircase is complex, requiring meticulous calculations of precise groupings of parameters such as dogleg beam dimensions, load capacities, and curvature radii. These [customized engineering solutions](#) are essential to ensure the staircase functions as intended.

Materials are a significant factor in the engineering process when customizing [curved stairs](#). This ensures that each design includes optimal structural elements based on the selected combination of [wood](#), [steel](#), [glass](#), or other materials. The curved stair's geometry and weight distribution are meticulously calculated to optimize appearance and performance.

The construction of [custom curved staircases](#) is a collaborative process requiring close internal and external coordination. In-house engineers work closely with external stamped engineers to guarantee the final stair design complies with all building code requirements. This collaboration ensures the staircase meets structural requirements without compromising the vision.

[The engineering team](#) uses advanced tools, including laser scanning and 3D mapping, to create precise designs that can be accurately constructed. Working with external engineers who provide stamped plans guarantees that each curved stair design is thoroughly vetted for safety and regulatory compliance.



## FABRICATION AND INSTALLATION TECHNIQUES

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The fabrication of [modern curved stairs](#) demands precision. Skilled artisans perfect every curve and angle using state-of-the-art tools and techniques with traditional woodworking methods.

Wood components are fabricated using advanced techniques such as CNC machining, steam bending, and 5-axis technology, while steel components are bent and formed by specialized partners.

[Southern Staircase](#) partners with global suppliers that specialize in intricate glass bending for curved glass elements.

## PRECISION IN INSTALLATION

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Before installation begins, [the installers](#) verify the site conditions to ensure the space is fully prepared to accommodate the staircase. The team works closely with builders, [architects](#), and other tradespeople to ensure seamless integration of the stairs into the space. Before the on-site assembly, components are often pre-assembled off-site to test the fit and functionality of the [curved stairs](#).

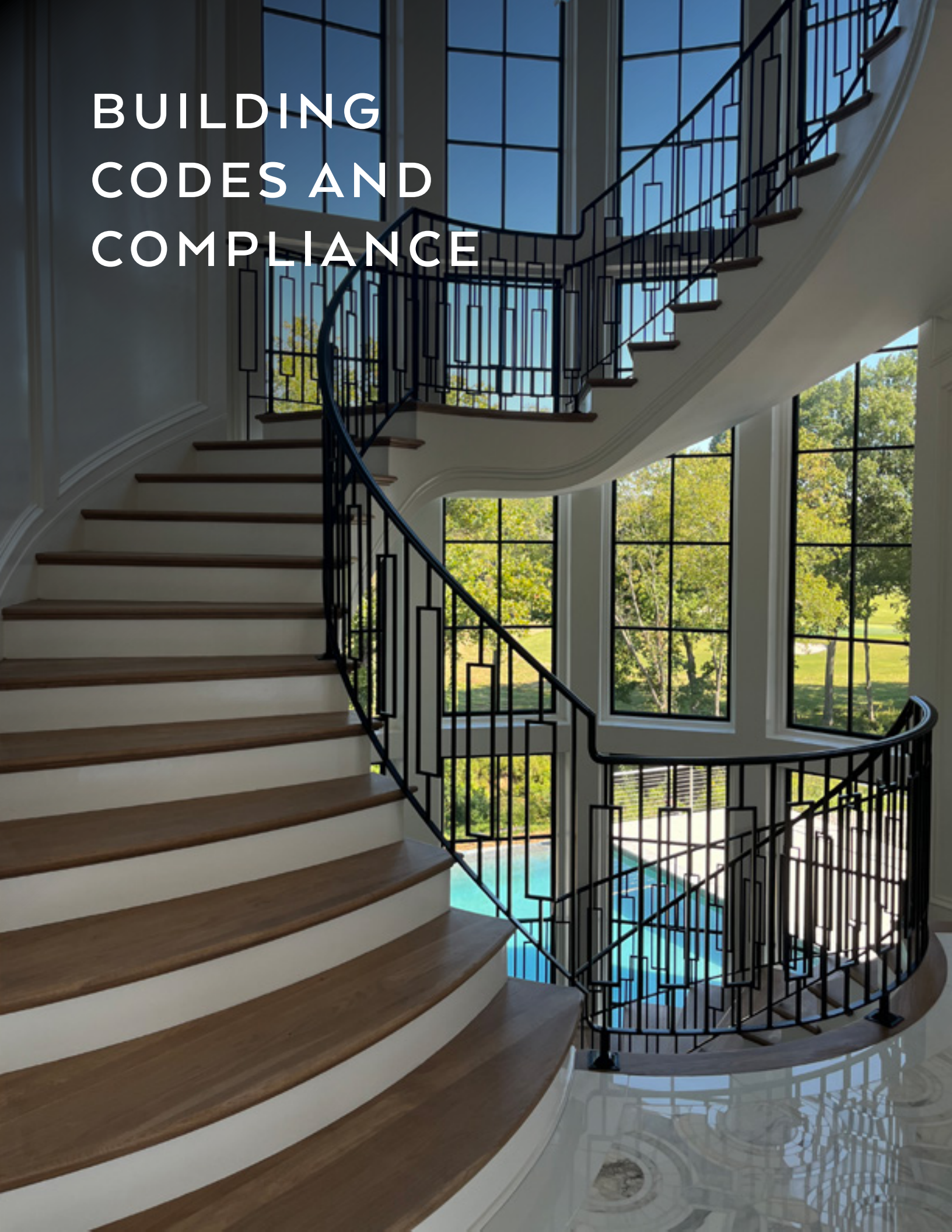
Specialized tools, including rollers and levers, make precise adjustments during installation. These allow for fine-tuning and perfect alignment, ensuring that every step of the process is executed accurately.

Anchoring and structural integration are imperative during this phase. Steel brackets and bolts secure key load points, while through-bolting ensures that each component is adequately reinforced. Structural elements, including LVL systems, are sometimes employed to replace rim boards, enhancing strength and ensuring long-term durability. Each installation stage is carefully executed to maintain the [curved staircase's](#) aesthetic charm and structural integrity.





# BUILDING CODES AND COMPLIANCE



# BUILDING CODES AND COMPLIANCE

For legality and functionality, [custom curved staircases](#) must comply with all relevant building codes and safety regulations. This ensures that every staircase meets the standards for approval and use in various environments while aligning with industry standards.

## LOAD CONSIDERATIONS

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When designing [curved staircases](#), load factors must be considered. Both residential and commercial staircases must accommodate various load types, including live and dead loads. Due to their unique geometry, curved stairs typically experience more complex load distribution than traditional [straight staircases](#). Ensuring the staircase is structurally sound to handle these loads is paramount.

The compliance standards for dynamic and static loads are consistent across residential and [commercial settings](#). **Dynamic loads**, often more challenging to calculate, represent the forces exerted when people walk or run up and down stairs. Ensuring the staircase can withstand these forces is vital, particularly in high-traffic commercial spaces. **Static loads** deal with the structure's constant weight and any furnishings or elements fixed to the staircase.



## INTERNATIONAL RESIDENTIAL CODE (IRC) VS. INTERNATIONAL BUILDING CODE (IBC)

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Building codes are categorized based on the type of structure in which the [curved staircase](#) is installed, with different standards applying to residential and commercial projects.

The International Residential Code (IRC) provides guidelines on minimum safety requirements, such as tread dimensions, riser height, and the overall structural design for residential staircases.

The International Building Code (IBC) governs the design of staircases for [commercial spaces](#). Unlike residential codes, the IBC includes additional safety considerations, such as the load-bearing capacity and fire resistance of construction materials.

Monumental stairs in commercial settings may also require specific fire safety provisions and the use of non-combustible materials. The IBC usually introduces more stringent regulations regarding the structural integrity and accessibility of these staircases to meet the higher volume of foot traffic expected in public spaces.

## HANDRAIL AND GUARD REQUIREMENTS

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In residential and commercial projects, [handrails](#) and guards are required to protect users of [curved staircases](#). They must be of an appropriate height and design to ensure users can maintain their balance while ascending or descending the stairs. The IRC and IBC have specific height requirements for handrails and guards, though they differ slightly between residential and commercial standards.

The IRC specifies that residential handrail heights should be between 34 and 38 inches measured from the stair tread nosing. The IBC requires a height between 34 and 38 inches for [commercial handrails](#). However, the handrail should be continuous without obstructions, making it easier for all users to grip.

Both codes ensure that [curved handrails](#) are designed to accommodate a wide range of users. Guards are often integrated into the staircase design and must meet specific height requirements to prevent falls. The IRC mandates that guards be at least 36 inches high for residential staircases, while the IBC increases this height requirement to 42 inches for commercial spaces.

## ADA COMPLIANCE AND FIRE SAFETY

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For [commercial staircases](#), compliance with the Americans with Disabilities Act (ADA) is necessary. ADA guidelines mandate certain design elements to ensure accessibility for individuals with disabilities, such as appropriate tread width, clear handrails, and sufficient headroom.

While monumental stairs may be exempt from specific provisions, such as the required number of [handrails](#) or specific width dimensions, accessibility must be addressed to ensure that a secondary accessible means of egress is provided. ADA compliance impacts curved stair design and may dictate the need for elevators, ramps, or other accessibility features within a space's design.

In addition to ADA compliance, fire safety regulations play a significant role in the design of commercial staircases. The stairs must be designed to ensure safe egress in an emergency, including fire-resistant materials, clear pathways, and safe handrail design. Building codes may require specific materials, such as fire-resistant-treated [wood](#) or [steel](#), for use in commercial spaces to prevent the rapid spread of fire.

In certain instances, monumental staircases in large commercial spaces are designed to serve as the primary egress route during emergencies, making it imperative that they comply with fire safety regulations.

## EVOLUTION OF CODES

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Building codes have become more granular recently, and updates have been implemented to address the latest safety concerns.

While some definitions have become more specific, these changes have allowed for more flexibility in the materials used in [curved stair design](#). This has opened the possibilities for [architects](#), engineers, and builders, allowing for more innovative stair designs. Newer codes may allow the use of [engineered wood](#) or composite materials, which were previously restricted, if they meet the necessary safety standards.





# DESIGN AND ON-SITE CONSTRUCTION



# DESIGN AND ON-SITE CONSTRUCTION

Creating [custom curved staircases](#) requires more than technical competence. The process leverages exact technical engineering with detailed design elements to ensure each staircase fits perfectly into its space while making a visual statement.

## PRECISION IN MEASUREMENTS

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One of the most important components of [curved staircase construction](#) is precision. Advanced technology, including laser scanning and 3D mapping, captures highly accurate site measurements, especially for more complex designs. These tools ensure the utmost precision in measuring the curvature, slope, and alignment, creating a foundation for flawless fabrication.

However, traditional methods, such as experienced hand measurements, are still essential for curved staircase projects.

## FABRICATION TECHNIQUES

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In addition to precise measurements, the fabrication process is key to ensuring each [curved staircase's](#) integrity and visual appeal.

[Southern Staircase](#) employs cutting-edge construction techniques, including CNC machining, steam bending, and 5-axis technology for wood. These advanced methods enable the team to craft wood elements with unparalleled accuracy, especially for the intricate curves and shapes required in [custom designs](#).

CNC machining allows for intricate cuts and joints, while steam bending creates smoothly curved elements from hardwoods. 5-axis technology adds another layer of precision, enabling the team to work with complex, multi-dimensional geometries and shapes that would be impossible or difficult to achieve manually.

A similarly high-tech approach is used to construct [curved staircases](#) using steel and glass components. Steel bending and forming are often outsourced to specialized partners with the necessary equipment and prowess to handle these demanding processes. This collaboration ensures the steel components fit perfectly into the curved stair design while maintaining strength and flexibility.

A select group of global suppliers handles curved glass fabrication, using state-of-the-art techniques to produce the high-quality, [custom glass](#) required for curved staircases. These carefully chosen suppliers employ advanced processes, including heat bending and tempering, to ensure the glass meets safety standards and seamlessly integrates into the staircase design.



## ON-SITE CONSTRUCTION AND COORDINATION

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The construction of [custom curved stairs](#) extends beyond the design and fabrication stages. The on-site construction process requires meticulous planning and coordination with contractors, [architects](#), and tradespeople.

One of the most challenging aspects of new construction is ensuring that the curved staircase effectively integrates into the architectural design. Southern Staircase closely collaborates with all parties to ensure that each staircase element perfectly aligns with the structure, ensuring the final product is installed precisely.

## JOINING AND ASSEMBLY METHODS

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The assembly of [custom curved stairs](#) is an intricate process that requires a combination of specialized techniques based on the material used.

Advanced adhesives and bolt attachments are employed for wood components to ensure strong, durable joints that can withstand the test of time. The adhesives are designed to provide a solid bond, while bolt attachments offer additional stability for larger or heavier stair components, such as [treads](#) and stringers.

Welding is the preferred method of joining components for steel rail systems. This technique ensures the structural integrity of the railings while allowing for the flexibility to create elegant, curved designs. The welded joints are carefully crafted to ensure seamless transitions and secure connections, providing durability and aesthetic appeal.



Before any assembly is considered final, [Southern Staircase](#) conducts rigorous internal testing to assess joint strength and the overall structural integrity of the stairs. This is necessary to ensure the [curved staircase](#) can support static and dynamic loads while maintaining its functionality over time.

## **INCORPORATING TECHNOLOGY WITH TRADITION**

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[Southern Staircase utilizes](#) cutting-edge technologies in every curved stair design project. These tools, including laser scanning, 3D modeling, and advanced CAD software, allow accurate designs to be seamlessly translated.

However, combining these technological advancements with traditional construction methods employed by [experienced artisans](#) is paramount. This fusion of modern technology with time-honored craftsmanship ensures that each [curved staircase](#) is precise and infused with the ingenuity that has been the hallmark of Southern Staircase's work for decades.

A custom curved staircase with a dark metal balustrade and light wood treads, set in a room with arched windows. The staircase is a double helix, with the upper and lower flights sharing a common central support. The balustrade features a dark, polished metal handrail and vertical spindles. The treads are made of light-colored wood, providing a contrast to the dark metal. The background shows a room with arched windows and a desk with a chair, suggesting a home or office setting.

# SOUTHERN STAIRCASE'S APPROACH TO CUSTOM CURVED STAIR DESIGN

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## GENERATIONAL KNOWLEDGE AND CRAFTSMANSHIP

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[Southern Staircase](#) employs a guild-like approach to training. They have built a legacy where expertise and craftsmanship are passed down through multiple generations, ensuring that every team member has the technical knowledge and deep appreciation for the expertise of crafting [custom staircases](#).

This generational knowledge is key to creating bespoke [curved staircases](#), setting the company apart from competitors who rely on parametric-driven designs or mass production. Every curve, joint, and material choice is made to deliver a stair design that is distinctly original and tailored specifically to the project's needs.

[Southern Staircase](#) understands that no two stair designs are alike. Each curved staircase presents its own unique set of challenges, requiring adaptable and innovative problem-solving techniques. The team's advanced skillset enables a tailored approach to each project's needs, ensuring that every staircase created is as unique as the space it inhabits.

## STRUCTURAL ENGINEERING EXPERTISE

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The team's structural engineering expertise is crucial when designing and installing [modern curved stairs](#), which requires a deep understanding of load-bearing principles and structural dynamics.

## QUALITY CONTROL

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Southern Staircase implements quality control throughout every project phase, from design to fabrication to installation. They perform multiple quality control checks at every stage, ensuring that each curved stair component meets stringent standards before proceeding to the next step.

## INDUSTRY KNOWLEDGE AND RELATIONSHIPS

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[With over four decades of experience](#), Southern Staircase has established strong relationships with [architects](#), builders, and material suppliers. These connections enable them to source premium materials and collaborate efficiently with professionals in other trades, ensuring that every project runs smoothly from consultation to completion.



# START YOUR CURVED STAIRCASE PROJECT WITH SOUTHERN STAIRCASE





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[Southern Staircase's](#) expertise in designing and constructing [custom curved staircases](#) is unmatched in the industry. This dedication to premium craftsmanship and innovative problem-solving guarantees that every curved staircase they build is a stunning centerpiece that enhances the functionality of residential and [commercial spaces](#).

Builders and industry leaders seeking to elevate their projects with [custom curved stairs](#) trust Southern Staircase as their preferred partner. With a focus on collaboration, meticulous attention to detail, and precise execution, Southern Staircase continues to set the standard in excellent curved staircase construction.



## READY TO TAKE YOUR CONSTRUCTION PROJECT TO THE NEXT LEVEL?

Contact the team to discuss your project requirements and  
learn how they can bring your stair design vision to life.

[CONTACT US](#)