Construction Considerations for Planned Development near the Basilica of Saints Peter and Paul Catholic Church

Chattanooga TN, Patten Parkway

Summary and Engineering Analysis
with assistance from Chat GPT based research

James M Poston, P.E. (104592)

ABOUT THE AUTHOR:

Mr. Poston is a retired Captain (O6) in the United States Navy (Reserve) with 30 years of experience and multiple command billets, acquiring 9.5 years of active-duty time including two deployments to the Middle East (Iraq 2006 and Afghanistan 2012-13). He is also a retired Principal Engineer and Senior Manager for the Tennessee Valley Authority with 40+ years of experience in power production and construction project management. Mr. Poston has done extensive work with the Federal Emergency Management Agency (FEMA) following declared Federal Disasters including earthquakes and typhoons in Alaska, and hurricanes in the US Virgin Islands, seeing first-hand the effects of poor foundation and structural engineering working as Site Inspector Task Force Lead. He currently works part-time as a Program Manager for Aviation Systems Engineering Corporation based in Patuxent River MD and teaches Systems Engineering (including Project Management) at the Graduate level for Johns Hopkins University, Whiting School of Engineering. Mr. Poston is a lifelong resident of the Chattanooga area (Whitwell High School 1979, UTC BSME 1984, and UTC MS-ENGR MGT 2004) and long-term parishioner of the Basilica of Saints Peter and Paul (since 1992).

Table of Contents

Construction Considerations Chattanooga TN, Patten Parkway

Executive Summary

The proposed development for Patten Parkway, adjacent to the Basilica of Saints Peter and Paul Catholic Church at 214 E 8th Street, could cause significant destructive damage to this 136-year-old structure. The analysis below will detail how the factors of soil and underlay characteristics will result in major construction efforts to stabilize the foundation and prevent movement under possible seismic loads with the development being in the East TN Seismic Zone (ETSZ). It is incumbent on the Planning Commission to properly address the possibility of irreparable permanent harm that may, and probably will, result from any major construction activity so near to this historic structure. ***Re-zoning approval should therefore be halted until further detailed study can be accomplished for the seismic and environmental impacts of such major construction in the historic area of Patten Parkway***. From the analysis, you will see that the only rational approach to any development is to firstly do no harm and preserve the historic nature of the area, but ***also to keep any construction efforts within the existing soil and foundation capabilities of the area***. Any effort beyond this could be disastrous for the public and the community.

Design Considerations:

For a 12-story building in seismic-prone Chattanooga, construction involves designing for lateral forces (sway) with robust lateral systems like shear walls, moment frames, and dampers, deep foundations, and potentially base isolation, all governed by strict IBC seismic codes, ensuring ductility, strong connections, and avoiding soft-story issues to protect against ground shaking and prevent collapse, keeping occupants safe during earthquakes.

Key Seismic Considerations & Implications:

1. **Seismic Hazard in Chattanooga:** While not California-level, ***<u>the New Madrid Seismic Zone can affect the area, requiring modern seismic design even for mid-rise buildings.</u>***

2. **Lateral Force Resisting Systems:**

    1. **Shear Walls & Bracing:** Reinforced concrete or steel shear walls and cross-bracing are critical to resist side-to-side (lateral) forces, providing stiffness and strength.

    2. **Moment Frames:** Steel or concrete frames designed to resist bending from lateral loads.

    3. **Diaphragms:** Floors and roofs act as horizontal elements to transfer seismic forces to the vertical walls/frames.

3. **Ductility:** Buildings must be designed to deform (bend and sway) without sudden failure, meaning ductile materials (steel, reinforced concrete) and proper detailing are crucial.

Foundation Design:

<u>Deep foundations or pile foundations may be needed to transfer loads to stable soil</u>, especially if the site has poor soil conditions (***see below***).

4. **Vibration Control:**
    1. **Dampers:** Viscous or tuned mass dampers can absorb earthquake energy, reducing sway and vibrations in tall structures.
    2. **Base Isolation:** Less common but highly effective; involves isolating the building from the foundation with flexible bearings to decouple it from ground motion.
5. **Building Configuration:** Avoid "soft stories" (e.g., open ground floors/parking) that are weak points; ensure uniform stiffness and strength throughout the building.
6. **Code Compliance:** Adherence to the International Building Code (IBC) seismic provisions (ASCE 7) is mandatory, dictating design loads and detailing for the specific seismic zone.
7. **Construction Quality:** Proper detailing of reinforcement, concrete mixes, and connections is vital; poor construction undermines even a good design.

In essence, a 12-story building here needs engineering that anticipates swaying and provides strong, flexible systems to dissipate seismic energy, ensuring it can withstand shaking without collapsing, a core principle of modern seismic engineering Foundation Design Considerations:

<u>Foundation design for a 12-story building in Chattanooga, TN, is heavily influenced by seismic considerations, requiring rigorous geotechnical investigation and engineered solutions that often go beyond simple shallow footings to handle the region's complex soil and geological conditions</u>.

Seismic Design Considerations:

Chattanooga TN, near Pattern Parkway, sits within the active **Eastern Tennessee Seismic Zone (ETSZ)**, meaning medium to high earthquake hazard, with frequent small quakes and potential for damaging ones, though large quakes are rare historically, requiring preparedness like securing items and considering structural improvements, as shaking can travel far. The area sees frequent minor quakes, with significant activity on old faults deep underground, and local geology can amplify shaking, so risk assessment is crucial for development.

Key Hazard Details:

- **Zone:** Eastern Tennessee Seismic Zone (ETSZ).

Construction Considerations Chattanooga TN, Patten Parkway

- **Activity:** One of the East's most active zones, with frequent small earthquakes (hundreds recorded annually).
- **Potential:** While historically large damaging quakes are absent, a M5.5+ could cause damage up to 40km away and shaking travels further in the East.
- **Risk Level:** Medium to High, with a 10% chance of damaging shaking in 50 years, according to Think Hazard" (https://thinkhazard.org/en/report/3256-united-states-of-america-tennessee/EQ, retrieved 12-7-2025).
- **Local Geology:** Tilted/folded rocks in the Valley & Ridge Province (where Chattanooga is) mean activity, and local soil can amplify shaking, notes ScienceDirect.com" (https://www.sciencedirect.com/science/article/pii/S2772467022000896?via%3Dihub, retrieved 12-7-2025).

Key Foundation Design Considerations:

1. Geotechnical Investigation and Site Class

A mandatory, thorough geotechnical investigation is the first step for structures in Seismic Design Categories C through F. Chattanooga's geology is characterized by folded sedimentary rock and variable soils, including expansive red clay, silt, and limestone-influenced terrain.

- **Soil Behavior:** Expansive clay soils expand when wet and contract when dry, causing ground movement that can lead to foundation settlement or heaving. This necessitates foundation designs that can bypass these unstable layers.
- **Site Classification:** The investigation determines the Site Class (A-F), which is based on the average shear wave velocity within the top 100 feet of the surface. Softer soils (Site Class D or E) can amplify ground shaking more than rock (Site Class A or B), increasing the seismic forces the foundation must withstand.
- **Seismic Hazards:** The investigation must specifically evaluate potential geologic hazards such as slope instability, liquefaction potential (where saturated granular soils lose strength during shaking), and excessive settlement.

2. Foundation Systems

For a 12-story building, which imposes high static and dynamic loads, **deep foundations** are typically more suitable than shallow ones, especially given the variable local soil conditions.

- **Deep Foundations:**
  - **Pile Foundations:** ***<u>Long, slender columns (concrete, steel, or timber) driven or drilled deep into the ground to reach a stable soil or bedrock layer</u>***. Helical piles are one type used in seismic zones to transfer loads to deeper, more stable strata.
  - **Drilled Piers:** Large-diameter concrete columns cast in place, often used for heavy loads in tall buildings.

  - **Pile-Raft Systems:** A combination of piles and a concrete mat (raft) foundation to distribute loads and resist both static and seismic forces.

- **Shallow Foundations:** Reinforced spread footings might be considered if the geotechnical investigation confirms very stable soil or competent bedrock close to the surface, but this is less likely for a 12-story structure in this region.

3. Seismic Design Requirements
Foundation design must meet the seismic provisions of the International Building Code (IBC) and standards like ASCE 7, which specify requirements based on the building's Seismic Design Category (likely C or D in Chattanooga, I am not an expert in ***Seismic Design***).

- **Ductility and Connections:** The foundation must be designed to accommodate movement and transfer forces to the lateral force-resisting system (shear walls, moment frames) without brittle failure. Connections between the foundation and the structure above must be robust and detailed for ductility.
- **Continuous Footings:** Exterior and interior braced walls must be supported by continuous, reinforced concrete or fully grouted masonry footings to ensure proper force transfer.
- **Dynamic Analysis:** The foundation design must account for dynamic bearing capacity and potential dynamic settlement under earthquake loading.

Summary
The design requires close collaboration between the structural engineer and a geotechnical engineer to select a robust foundation system, likely a deep foundation (piles or piers), that is specifically tailored to the local soil profile and can safely transfer the significant seismic forces to stable ground.

Soil Types and Composition:

The soil stability around Patten Parkway in downtown Chattanooga is complex, characterized by **variable, clay-rich soils** that are susceptible to expansion/contraction with moisture changes, and the presence of **potential sinkhole risks** due to underlying carbonate bedrock. Geotechnical investigations are generally required for construction in the area.

Key factors affecting soil stability in this area:

- **Soil Composition**: Chattanooga generally has heavy clay soils, which are highly susceptible to erosion, and silt loam, which has a low infiltration rate. In the downtown area, near-surface soils often consist of lean clay, clayey silt, and sandy silt, some of which may have a low potential for expansion.

Construction Considerations Chattanooga TN, Patten Parkway

- **Moisture Sensitivity**: The clay-rich soils can expand and contract significantly with seasonal fluctuations in precipitation, a process known as soil heave. This can lead to gradual shifts, settling, and foundation damage over time.
- **Geological Formations**: The ***area is underlain by carbonate bedrock, which is soluble and presents a risk of sinkholes (karst features).*** While specific evidence of sinkholes may not be present in every single boring, evidence of solution weathering is typical, and sinkholes have occurred within Hamilton County.
- **Topography**: While Patten Parkway itself is in the relatively flat downtown area (originally a flood plain of the Tennessee River), the broader Chattanooga area has steep, hilly terrain. Slopes, especially those that are steep and undercut, are at ***high risk for slope instability and landslides***.
- **Urban Fill**: In older, urban areas like downtown, historical industrial activity means that ***the soil may contain uncharacterized fill material, which can vary widely in composition and stability and may also contain contaminants like lead***.

For any construction or development project, a site-specific geotechnical investigation and engineering report is essential to assess the specific subsurface conditions and determine appropriate mitigation measures, such as soil stabilization techniques or specific foundation designs.

Examples of named buildings in downtown Chattanooga with widely known, major structural failures explicitly attributed to soil instability is limited. However, ***the history of the downtown area points to widespread challenges related to soil conditions and development practices***:

- **"Underground Chattanooga" (General Area)**: Many historic downtown buildings (e.g., portions of the Loveman's Building, the Sports Barn, and areas near the Tivoli Theatre and **Patten Parkway**) were ***originally built at a lower elevation***. The entire street level of downtown was raised by a full story in the late 19th century to escape regular flooding from the Tennessee River. Buildings that didn't raise their ground floors were left with damp basements and sealed-off lower levels, ***indicating significant historical issues with water saturation and ground dampness at the original grade***.

Construction Considerations Chattanooga TN, Patten Parkway

- **Walgreens Parking Lot (Near downtown)**: A significant 17-foot-deep sinkhole opened up in a Walgreens parking lot in 2018. While poor infrastructure (like leaking sewage pipes) was considered a likely immediate trigger, ***geologists noted that the underlying soluble limestone bedrock and heavy rainfall were contributing factors in the general Hamilton County area***.
- **New Lookouts Stadium Site (Southside)**: The soil at the site of the new baseball stadium on the Southside was found to have dangerous levels of lead contamination from historical foundries (U.S. Pipe and Wheland Foundry). While this is a contamination issue rather than a stability issue, ***it highlights the presence of variable "urban fill" which can present stability challenges*** if not properly remediated or compacted.
- **General Residential Areas**: Foundation repair companies frequently note that common residential foundation issues in Chattanooga stem from ***the region's expansive red clay soils, which expand when wet and contract when dry, putting stress on foundations, and the presence of underlying karst topography that leads to sinkholes***.

In areas like downtown Chattanooga, where the soil is characterized by expansive clay, variable fill, a high water table, and underlying soluble bedrock (karst), standard shallow foundations are often insufficient. The ***most recommended foundation types are deep foundations that transfer the structural load to more stable, deeper layers or bedrock.***

Here are the recommended foundation types and design considerations:

Recommended Foundation Types

- **Deep Foundations (Piers and Piles)**: ***This is generally considered the most effective solution for challenging soil conditions in Chattanooga***. These systems involve driving or drilling long columns of steel or concrete deep into the ground until they reach a stable layer of soil or the underlying bedrock.
  - **Helical Piers and Push Piers**: These are commonly used for both new construction and repairing existing, settling foundations. They anchor the

structure to stable ground below the active, moving surface layers, providing lasting stability.

  - **Drilled Shafts/Caissons**: Similar to piles but often larger in diameter, these are reinforced concrete columns that can handle significant loads, ideal for commercial buildings.

- **Raft/Mat Foundations**: A raft foundation involves a thick, heavily reinforced concrete slab that extends over the entire footprint of the building, much like a mat.
  - This design helps distribute the building's weight evenly across a broad area, which reduces the overall pressure on the soil and mitigates uneven settlement caused by weak topsoil or high water tables.
  - The specialized Waffle Mat foundation is a variation designed specifically for highly expansive clay soils, as it incorporates void areas to accommodate soil expansion and contraction without damaging the slab.
- **Pier and Grade Beam Foundations**: This system uses piers anchored to bedrock or stable soil, connected by grade beams at the surface. It provides excellent stability and keeps the main structure elevated, which is beneficial in flood-prone or high-moisture areas.

Potential Damages expected if deep pile or similar Foundation construction occurs within 500 to 1000 ft of a 136-year-old church building and site:

Deep Pile Foundation Work within 500 ft of a **136-year-old church** risks significant damage from:

- **Vibrations**
- **Soil Disturbance** (subsidence/settlement)
- **Water Table Changes**, potentially causing:
  - Cracks In Masonry
  - Wall Bulging
  - Structural Shifting
  - Deterioration Of Historic Mortar
  - **Even Collapse**, especially with older structures having less robust foundations than modern buildings.

Construction Considerations Chattanooga TN, Patten Parkway

- Expect **Issues** like:
    - **Ceiling Supports cracking / failure** (including loss of gold leafing)
    - Plaster Cracking
    - Uneven Floors
    - Distorted Window Frames and cracking of **Tiffany stained glass**
    - Mortar Degradation, requiring:
        - Careful Monitoring,
        - Mitigation Plans (like Underpinning or Grouting)
        - Historical Building Expertise for Assessment.

Potential Damages & Mechanisms:

1. **Vibrations**: Pile driving creates intense ground vibrations that travel through soil, shaking the old church's delicate structure, causing plaster cracks, loosening mortar, and potentially damaging historic features.
2. **Soil Settlement/Subsidence**: Deep excavation and pile installation can displace or compact soil, changing its load-bearing capacity, leading to differential settlement (uneven sinking) of the church's foundation.
3. **Water Table Alteration**: Dewatering for deep excavations can lower the water table, drying out clay soils beneath the church, causing them to shrink and leading to settlement.
4. **Heave**: Conversely, placing heavy piles or dewatering/rewatering cycles can cause soil to swell (heave), lifting parts of the foundation.

Signs to Watch For:

- Cracked plaster or brickwork (especially stair-step cracks).
- Sticking doors or windows.
- Uneven floors or visible slanting.
- Bowed walls or bulging masonry.
- **Cracks and ultimate failure of historic wooden structures** in the roof and ceiling.

- Damaged windowpanes or frames. **This alone is a vital consideration with priceless Tiffany made stained glass windows and the US Government supplied Star window behind the Pipe Organ in the sanctuary**.

Mitigation & Importance of Experts:

- Geotechnical Studies: Essential to understand soil conditions and vibration impacts.
- Vibration Monitoring: Real-time monitoring during construction.
- Structural Assessment: Pre- and post-construction surveys by heritage engineers.
- Remedial Measures: Underpinning, soil grouting, or foundation underpinning might be needed.

Given the age and historic nature of the church, professional consultation with geotechnical engineers and historic preservation experts is crucial _before_ any work begins. It is not at all certain that adequate measures have been taken to examine and plan for possible damage due to construction.

Analysis and Conclusions:

It is my professional opinion that there is a **SIGNIFICANT** possibility of serious, irreparable, permanent damage to the structure and surrounds of the Basilica of Saints Peter and Paul Catholic Chursh at 214 E 8th St Chattanooga TN 37402. I therefore urge, in the strongest terms, that the Hamilton Co and City of Chattanooga to immediately halt construction plans and to NOT grant re-zoning as currently planned. If there is construction at the proposed development site in the future, it must be no higher than can be supported by the existing soil structure and foundation capability. Any major disturbance of the soil and underlayment risks irreparable harm to a sacred space with deep historical ties to the City of Chattanooga (including the Civil War), and under the purview of His Holiness Pope Leo XIII and the Roman Catholic Church.

James M Poston, P.E. (104592)

JAMES MICHAEL POSTON
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 104592
STATE OF TENNESSEE