STRUCTURAL FOCUS

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Reference: **ASSESSMENT REPORT & MITIGATION RECOMMENDATIONS**
POTENTIAL PHYSICAL IMPACTS TO STAHL HOUSE DURING CONSTRUCTION
1501 MARLAY DRIVE
LOS ANGELES, CALIFORNIA
[SF PROJECT NO. 24377]

Dear Jonathan,

Structural Focus has completed our review of potential physical impacts to the Stahl House, an architectural icon and nationally recognized historic resource, caused by the construction of the proposed single family home at 1501 Marlay Drive in Los Angeles, California. The purpose of this letter report is to convey our understanding of the risk of structural damage to the Stahl House from the proposed adjacent construction project, with particular respect to ground vibrations generated during the construction process, and to provide recommendations for updates to the design and construction methods to help mitigate those risks.

We have based this report on our review of the following documents:

- Architectural drawings, Hillside Residence, 1501 Marlay Drive, Planning Submittal, prepared by Paul Coleman, Architect, dated March 29, 2019;
- Historic Resources Assessment Report, 1501 N. Marlay Drive, prepared for EcoTierra Consulting by South Environmental LLC, dated November, 2022;
- Initial Study (redline), 1501 Marlay Drive Project, prepared for the City of Los Angeles Department of City Planning by EcoTierra Consulting, dated 2023;
- Geologic and Soils Engineering Exploration, 1501 Marlay Drive, prepared for Mr. Coleman by Schick Geotechnical, Inc., dated April 4, 2014;
- Addendum Geologic and Soils Engineering Exploration, 1501 Marlay Drive, prepared by Schick Geotechnical, Inc., dated December 17, 2018;
- Addendum Geologic and Soils Engineering Exploration, Revised Retaining Wall Analyses and Kinematic Analysis, 1501 Marlay Drive, prepared by Schick Geotechnical, Inc., dated June 19, 2020;
- Various Geology and Soils Report Approval Letters sent to Sara Schusterow, signed by Edmond Lee and Ying Liu, Los Angeles Department of Building and Safety, dated June 17, 2016, September 13, 2016, April 24, 2019, and July 22, 2020.

This report is also based on our discussions with Wayne Schick, Certified Engineering Geologist in the State of California, and Robert Nigbor, PhD., a licensed Professional Civil Engineer in the State of California. Mr. Schick is the author of the geologic and soils engineering reports for the project, and Dr. Nigbor is a consulting earthquake engineer specializing in vibration monitoring and applied geophysics and is a retired Research Engineer at the University of California Los Angeles Samueli School of Engineering.

Proposed 1501 Marlay Drive Project

The proposed single-family home at 1501 Marlay Drive is located on a steep hillside in the Hollywood Hills West neighborhood of Los Angeles. The single-story plus basement and sub-basement home encompasses 3,100 square feet and is approximately 57 feet 6 inches by 33 feet in plan, and approximately 28 feet in above-grade height. The home has a subtle, modern design that responds to the physical characteristics and constraints of its site and neighbors. As the design is in the planning phase, a structural design has not been fully developed. The design concept in the architectural planning submittal depicts a glass-fronted, low-profile, reinforced concrete slab and shear wall structure embedded into the hillside, supported on conventional shallow foundations. The home is set in front of a tall, reinforced concrete retaining wall designed to be integral with the structure of the home. The retaining wall wraps around the sides of the home, achieving a maximum height of 57 feet 10 inches from the lowest point on the site, and is supported on a series of reinforced concrete soldier piles extending a minimum of 10 feet into bedrock below the lowest point of the future excavation, as required by the geologic and soils reports for the project. A structural engineer will need to design a building structure and retaining wall system consistent with the recommended criteria in the approved geologic and soils reports for the project.

The Stahl House

Located directly north of the Marlay property at 1635 Woods Drive, the Stahl House is widely recognized as a superior example of the International Style of architecture and is among the most iconic residences in Southern California. Designed by architect Pierre Konig and built between 1959 and 1960 as part of *Arts & Architecture* magazine's Case Study House Program, the Stahl House gained status as a Los Angeles Historic-Cultural Monument in 1999. In 2013, the Stahl House was listed on the National Register of Historic Places.

The Stahl House is a single-story, steel-frame structure set on an L-shaped concrete pad with a flat roof and floor-to-ceiling glass walls, shaded by the overhanging roof deck at the rear of the home. A swimming pool and patio are situated at the rear of the home in the space bounded by the orthogonal wings to the north and east. The building foundation consists of a set of reinforced concrete piles into bedrock connected at the top by reinforced concrete grade beams that support the reinforced concrete slab floor. Each concrete pile location supports a steel column, which in turn provide support for the wide flange steel beams at the roof level. The roof is constructed of steel decking spanning between the steel beams.

The Stahl House is positioned at the edge of a sharply descending south-facing slope, composed of moderately weathered granite bedrock as described in the Schick report. 1501 Marlay is at the base of the slope. The slope ranges in vertical height from 10 to 25 feet and has a gradient from 1:1 to 0.8:1.

Potential Impacts of Construction Vibration

Ground vibrations are generated during in-ground construction activities such as drilling, excavation, and compaction, as well as by equipment traveling on the ground surface. Traveling generally as surface waves, ground vibrations attenuate, or lose intensity, as they move through the earth away from the source. Varying types of soil and rock attenuate vibrations at different rates. Vibration can be a nuisance to occupants, and may potentially cause damage to structures, their finishes, or their contents.

Potential Direct Vibration Impacts

Vibration has two primary characteristics – the frequency and the amplitude. Amplitude is typically defined by peak particle velocity (PPV) and is measured in inches per second (in/sec). Frequency is measured in Hz, or cycles per second. Ground vibrations excite structures, and the structure typically amplifies the ground vibration, generating higher accelerations, velocities and displacements within the structure than those measured at ground level. The movement may deform the structure as the roof and floors potentially move at different rates, or even in different directions, relative to each other and to the ground. This deformation generates internal structural stresses which may exceed the strength of the material the structure is made of, causing, for example, stretching, twisting, and warping of steel or cracking or spalling of concrete. At high enough stress, the material, and hence the structure, will not be able to return to its initial position or shape, and the damage is permanent. This may cause a structure to no longer meet functional or aesthetic requirements. Movement and deformation can also cause a structure to become unstable, presenting an immediate hazard to occupants.

Generally, the greater the amplitude and the lower the frequency, the greater the potential for damage to the structure. Fortunately, construction vibrations are generally lower in amplitude and higher in frequency than those vibrations prone to cause damage to buildings.

In 2006, the Federal Transit Administration published common values of PPV for common construction activities at a distance of 25 feet away from the source. Selected activities and associated amplitude values are presented in Table 1, below.

Table 1. PPV Levels at 25 ft Caused by Common Construction Activities

Activity	PPV @ 25 ft (in/sec)
Hammer Pile Driving	1.518
Vibratory Compaction	.210
Large Bulldozer	.089
Caisson / Auger / Core Drilling	.089
Jackhammer	.035
Loaded Trucks	.076

Information from Vibration Source Levels for Construction Equipment, Federal Transit Administration. 2006, Transit noise and vibration impact assessment. FTA-VA-90-1003-06. Office of Planning and Environment, Washington, D.C., Prepared by Harris Miller & Hanson, Inc., Burlington, MA.

The frequency of construction vibrations are generally higher than 15 Hz. Structures are most susceptible to frequencies between 4 and 12 Hz, the zone of natural horizontal resonance of most structures. Damage has been observed in structures that were exposed to vibration amplitudes above 1.3 in/sec when frequencies were 2 to 5 Hz, and above 4 in/sec when frequencies were 60 to 450 Hz. Some examples of typical frequency ranges for various construction activities are shown in the Table 1.

Table 2. Typical Frequency Ranges of Common Construction Activities

Activity	Frequency Range
Demolition	15-30 Hz
Hammer Pile Driving	20-40 Hz
Vibratory Compaction	25-45 Hz
Bulldozer	5 – 30 Hz
Auger / Core Drilling	20 – 200 Hz (Dominant Freq. = 31.5 Hz)

The most common type of damage from vibrations related to construction, and the first type initiated, is cracking of rigid, non-structural wall finishes like drywall, plaster or stucco that form during shaking of the structure. This kind of direct damage is generally not a safety concern or a threat to the integrity of the structure, and most structures will reliably return to their original position.

Vibration generated by the proposed downslope construction will travel into the deep foundations of the Stahl House and up into the superstructure, where the energy will dissipate. The steel frame of the building is relatively flexible, with a relatively low natural frequency for a residential structure. Large enough vibrations at lower frequency could generate inertial acceleration of the roof mass, and related movement will cause stress concentrations to develop near the welded beam-column connections. Realistically, if incoming vibrations from construction are well-controlled at the source, the induced vibrations will not generate acceleration and structural displacement on the order required to exceed the elastic response of steel or cause structural damage.

Of non-structural concern are the rigid, plate glass panels bounded by the steel frame. Vibration and displacement of the frame has the potential to create corresponding vibration in the plate glass, as well as stresses in the glass that could lead to cracking. The details of this system and the magnitude of movement of the structure will dictate the ability of the system to accommodate any vibration without incident. It is important to note that the steel frame/plate glass system is evidently able to withstand vibrations caused by high wind events, as well as expansion and contraction of the steel roof and frame under the day/night heat cycle, suggesting the assembly will be able to accommodate vibrations from nearby construction. Nevertheless, it is always wise to limit the amplitude of vibrations in glass, and it may be appropriate to install convenient, temporary adhesive attachments that dampen vibration and protect the glass from damage or consider other protective solutions.

The most significant direct source of vibration from the proposed construction at 1501 Marlay will be the drilling of the soldier piles supporting the excavation and retaining/impact wall at the rear of the property. The method and speed of drilling affects the amplitude and frequency of vibration, as does the nature of the underlying material. (The granite bedrock forming the hillside that separates the Stahl House from 1501 Marlay will readily transmit vibration energy, as hard rock generally exhibits low vibration attenuation and maintains the higher frequency content.)

Potential Indirect Vibration Impacts

Serious, indirect damage can develop when construction vibration induces settling of soils, possibly leading to uneven displacement of foundations or slabs, generating stress and deformation in the structural framing system above. This type of damage may compromise the structure and require repair.

Per the geologic engineer, the massive, moderately hard to hard underlying bedrock at the site is not susceptible to settlement due to construction vibration. Since the Stahl House foundations are piles extending into this bedrock and connected by grade beams, differential settlement of the foundation system caused by construction vibration is improbable, as are any related adverse impacts to the superstructure.

Slope Instability

Significant hillside excavations present the obvious concern of overall slope stability during and after construction. Slope instability has potentially catastrophic consequences to structures above, on, or below the slope.

The geologic and soils reports for this project have determined various factors of safety against slope failure for different failure mechanisms, and the updated Kinematic analysis shown in the 2020 Addendum by SGI demonstrates that the ascending cut slope is kinematically stable when properly shored and after construction of the new retaining wall. Per Shick, the new reinforced concrete retaining wall and pile foundation will ultimately improve the overall stability of the slope, as the slope in its current condition exhibits factors of safety below 1.0.

The reports for the project provide parameters for the soldier pile system to accommodate the gradual excavation as well as recommendations for lagging design to appropriately resist earth pressure prior to placement of the concrete wall. This is a standard method of excavation in order to install new retaining walls, and performed correctly will provide adequate stability to the slope during construction.

Settlement Due to Retaining Wall Deflection

Cantilevered retaining walls are designed to deflect at the top up to 1% of the total height upon loading. Substantial deflection can lead to settlement of soil and structures above the retaining wall. The geologic and soils report for the project recommends that the structural engineer design the retaining wall and its foundation in a way that prevents or minimizes any deflection. This would entail designing strong and stiff systems with near zero deflection.

Published Vibration Limits

The California Environmental Quality Act (CEQA) documents have relied on the Federal Transit Authority (FTA) guidance for noise and vibrations generated by construction. FTA guidance is to limit peak particle velocity (PPV, in/sec) in order to prevent adverse structural impacts. The limits on nearby construction activities for various building types are listed below.

- Project construction activities leading to ground-borne vibration levels exceeding 0.5 PPV at the nearest off-site reinforced concrete, steel, or timber building.
- Project construction activities leading to ground-borne vibration levels exceeding 0.3 PPV at the nearest off-site engineered concrete and masonry building.
- Project construction activities leading to ground-borne vibration levels exceeding 0.2 PPV at the nearest off-site non-engineered timber and masonry building.
- Project construction activities leading to ground-borne vibration levels exceeding 0.12 PPV at buildings extremely susceptible to vibration damage, such as historic buildings.

Buildings extremely susceptible to vibration damage include unreinforced masonry buildings, unretrofitted tilt-up concrete wall buildings, wood-frame multi-story buildings with soft, weak, or open front walls, and non-ductile concrete buildings.

The above standards could be interpreted to mean that vibration caused by construction activities would be limited to 0.12 in/sec for all historic buildings, including the Stahl House. This stringent limit on vibrations is appropriate for fragile buildings. In that context, it should be recognized that while the Stahl House is a recognized historic resource, it is a modern steel frame building and simply does not have the same structural vulnerabilities to vibration as buildings otherwise categorized as “extremely susceptible” to vibration. The 0.12 in/sec vibration limit is arguably overly conservative.

In August of 2024, the City of Los Angeles Department of City Planning released a document titled *Construction Noise and Vibration: Updates to Thresholds and Methodology*. This document was developed with input from a Technical Advisory Committee of experts in acoustics and environmental science, with the intent of implementing reasonable standards consistent with other local jurisdictions. For construction noise and vibration, the document shifts from the FTA recommendations to align instead with Caltrans’ standard *Transportation and Construction Guidance Manual,* updating thresholds the Planning Department uses to evaluate a project’s environmental impacts in accordance with the (CEQA). To prevent damage to nearby buildings, Caltrans limits Peak Particle Velocity (PPV) generated by construction activities for different building classifications as follows:

Classification	**Maximum PPV (inches per second)**
Fragile Buildings	0.1
Historic Buildings	0.25
Older Residential Structures	0.3
New Residential Structures	0.5
Modern Industrial / Commercial Buildings	0.5

(Note, there is no limit established by Los Angeles for preventing human annoyance from construction vibration during daytime hours on weekdays.)

Research conducted by Mark Svinkin presented at the 19th International Conference on Soil Mechanics and Geotechnical Engineering and provided in his corresponding publication titled “A choice of proper criteria for soil and structural vibrations from construction and industrial sources” reviews several standards for vibration limits. Through this survey, Svinkin is able to establish a frequency-independent safe vibration limit for structures of 2.0 in/sec PPV. Vibrations below this level are generally incapable of causing even cosmetic damage to most structures, including steel buildings. Svinkin notes that a 2.0 in/sec is the maximum vibration generated by human activity such as walking, jumping, slamming doors, etc. in residential structures. The PPV values recommended by the Planning Department are well below Svinkin’s limit.

Recommendations for Vibration Mitigation

1. Require Construction Methods to Limit Vibration – Core Drilling in Lieu of Impact Drilling

   Our primary and most important recommendation is to prohibit percussive, impact, or hammer drilling and allow only auger or core drilling for this project. Impact drilling is commonly used when drilling through hard rock like granite. However, this method generates significant ground-borne vibrations as the drill combines repeated weight-driven impacts to break up the rock with rotary motion. When vibrations are an important consideration, the widely accepted solution is to employ core drilling instead. We recommended requiring a core-drilling method with diamond or tungsten carbide drill bits for all drilling operations on this project. Core drilling is a safer and less disruptive method for drilling through hard rock than percussion drilling and produces significantly lower vibrations than other drilling methods.

From the FTA research, we can see that the observed PPV at 25 ft of .089 in/sec generated by core drilling is comfortably lower than both the widely accepted damage threshold for residential structures of 2.0 in/sec published by Svinkin, and the vibration receptor limit of 0.25 in/sec provided by the LA Department of City Planning. Knowing that the direct vibration travel distance through the soil is greater than 75 feet to the Stahl House, we can see that utilizing core drilling will significantly contribute to the prevention of damage to the Stahl House caused by construction at the 1501 Marlay site.

2. Establish Vibration Limit & Vibration Monitoring Program

   We recommend establishing a vibration limit aligned with the 2024 updates provided by the Los Angeles Department of City Planning, and reflecting the historic nature of the Stahl House. The limit should be set at a PPV of 0.25 in/sec. While it is not anticipated that sensors can be positioned directly at the Stahl House, a sensor should be placed upslope, near the property line at the north boundary of the property. The sensor will detect any vibration exceeding the vibration limit.

   The implementation of an automated system that will remotely alert key personnel via their mobile device if the limit is exceeded will be useful. The recipients of the alert will then direct the construction crew to cease operations, determine the source of the vibration, and use alternate methods to reduce vibration. This may involve reducing drill speeds, reducing jackhammer force, staggering activities, or placing vibration damping mats under machinery to absorb vibrations.

3. Monitor Slope & Retaining Wall for Movement

   We strongly recommend implementing a system to detect any slope movement or retaining wall displacement during construction. This kind of monitoring program will provide added assurance that the slope remains stable, and provide an opportunity to implement appropriate preventative measures should movement be detected.

4. Conduct Continuous Data Collection

   Maintaining continuous data collection of PPV values generated during construction is good practice. This functionality of the monitoring device will provide a record demonstrating that established vibration limits were not exceeded.

5. Preconstruction Survey

   We recommend conducting a pre-construction survey of the Stahl House prior to construction, if possible. It is important to document the existing condition of the home with photographs prior to any work being done. Doing so ensures the nature of any impact that may occur during construction is well-understood and helps facilitate any displacement analysis that may occur subsequent to the project.

Conclusion

The hillside construction of 1501 Marlay Drive necessitates thoughtful strategies to prevent any adverse physical impacts to the neighboring Stahl House. While certain design aspects of both homes, as well as properties of the site, work in favor of that goal, it is recommended that the project implement the drilling methodology described as an active measure to limit vibration to non-damaging levels, and consider implementing the more passive strategies in the remaining recommendations. We believe this approach will allow the project to proceed consistent with the principles of historic preservation of the Stahl House.

Should you have any questions related to this report, please do not hesitate to contact Structural Focus.

Sincerely,
STRUCTURAL FOCUS

Samuel Mengelkoch, S.E.