



DONAN[®]

PREPARED FOR:

MR. GERARD VARRONE
LIBERTY MUTUAL INSURANCE COMPANY
P.O. BOX 515097
LOS ANGELES, CALIFORNIA 90051-5097

MS. MELANIE STURGEON
1211 SOUTH BARKLEY
MESA, ARIZONA 85204-5912
CLAIM NUMBER: 046096968-01
DONAN PROJECT NUMBER: 55-21070005-0

PREPARED BY:

DONAN ENGINEERING CO., INC.
12450 LAKE STATION PLACE
LOUISVILLE, KENTUCKY 40299
800-482-5611
ARIZONA COA: 17766-0
EXPIRATION DATE: DECEMBER 31, 2021

JULY 26, 2021

MICHAEL DRINKWATER, P.E.
FORENSIC ENGINEER
ARIZONA P.E.: 62712
EXPIRES: SEPTEMBER 30, 2022

John G. Donan, Jr., P.E.
Chairman of the Board

J. Lyle Donan, P.E.
President, CEO



CORRESPOND TO:
Donan Engineering Co., Inc.
12450 Lake Station Place
Louisville, Kentucky 40299
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July 26, 2021

Mr. Gerard Varrone
Liberty Mutual Insurance Company
P.O. Box 515097
Los Angeles, California 90051-5097

RE: **Ms. Melanie Sturgeon**
1211 South Barkley
Mesa, Arizona 85204-5912
Claim Number: 046096968-01
Donan Project Number: 55-21070005-0

Dear Mr. Varrone:

At your request, on July 12, 2021, a study was made on the house at the above-referenced address. The purpose of the study was to determine the cause of the displaced floor. Ms. Melanie Sturgeon was present to point out areas of concern and to provide firsthand information. This letter, with the enclosed photographs, is the report of my findings and conclusions.

Description of Property

For purposes of this report, the house is considered to face west toward South Barkley (Photographs 1 through 4). The house is a single-story, wood-framed structure constructed over a concrete slab-on-grade foundation. The exterior walls are clad with a combination of wood and stucco, and the roof is covered with dimensional-style asphalt shingles. According to Ms. Sturgeon, the house was built in the 1980s, and she has owned it for 27 years.



Background

Ms. Sturgeon provided the following information. A roof leak developed and was repaired about two years ago, at the northwest corner of the house. No water has leaked through the roof since the repairs were completed.

In mid-June 2021, the carpet in a bedroom at the northwest corner was removed. A crack in the underlying concrete slab was first noticed after the carpet was removed. No changes in the water bill have been noticed and no plumbing repairs have been completed in years.

Observations

A crack in the concrete slab is up to 1-inch wide with sharp, bright edges and spans north-south approximately 4 feet east of the west wall of the northwest bedroom (Photographs 5 through 7). The crack extends into a bedroom to the south and turns toward the west edge of the house. The crack intersects the west edge of the foundation approximately 12 feet south of the northwest corner (Photographs 8 and 9).

In the northwest bedroom, the baseboard trim is tight to the top of the slab on the east side of the crack (Photograph 10). At the northwest corner, a 3 inch gap is between the bottom of baseboard trim and the top of the slab (Photograph 11).

East of the crack, the floor slab is level and free of cracks (Photograph 12).¹ West of the crack the floor slab slopes down 2.0 and 1.3 degrees toward the west and north, respectively (Photographs 13 and 14).

The top of a window opening on the west wall of the northwest bedroom is level (Photograph 15). Comparative moisture readings of the ceiling at brown stains at the northwest corner and the ceiling away from brown stains are zero (Photographs 16 and 17).²

¹ Normal construction tolerance for level or plumb, as defined by Donan Engineering, is ± 0.4 degree.

² A Tramex Moisture Encounter capacitance-type meter was used for nondestructive moisture detection. Moisture levels for wood are given as a percent moisture content, while a dimensionless scale from 0 to 100 is used to provide comparative moisture levels in drywall, plaster, and roofing materials. Comparative values cannot be used to compare dissimilar materials with each other.

Gutters are not on the house near the northwest corner (Photograph 18). Grade slope readings near the north end of the west side are 1.4 percent down, toward the foundation (Photograph 19). Cracks in stucco with rounded edges and that are not offset horizontally on opposing edges extend from the corners of window openings (Photograph 20).

Near the west end of the north wall, grade slope readings are 1.7 percent down, toward the foundation (Photograph 21). Cracks with rounded edges, that are not offset on opposing edges, and that are surrounded by paint that does not match the prevailing wall color extend from windows (Photographs 22 and 23).

All water outlets inside and outside the house were turned off so that a leak detection test of the domestic supply plumbing could be performed. The water meter was monitored for 28 minutes and did not change during the test (Photographs 24 and 25).

Testing

Leak Detection Testing

American Leak Detection completed a leak test of the domestic plumbing on July 20, 2021. The report from that test says that no leaks are in the supply plumbing. According to the report, a leak test of the wastewater plumbing is not possible due to the absence of cleanouts. The report says that the nearest wastewater plumbing to the northwest corner is approximately 30 feet south, near the north wall of the garage.

Key Concepts

Differential Settlement

When soil experiences a force, it compresses and distributes the load to the surrounding soil. The weight of a structure imposes a weight load to the soil under the structure. Virtually all structures built on soil experience settlement because of compression of the underlying soil. The specific characteristics of settlement including rate and amount of settlement vary widely because of the variation of soil characteristics and construction practices. Settlement may occur immediately after loading and stop immediately, or it may continue for many years. The best ways to control settlement are to use proper soil to support the structure, to compact the soil to the proper density, and to manage surface water drainage

around foundations. Building on different types of soil within the building footprint can also cause differential settlement.

Settlement becomes a problem when a building does not settle uniformly. The non-uniform settlement of a building is referred to as differential settlement, and is usually indicated by cracks in foundations, cracks in interior or exterior wall coverings, cracks in masonry veneers, uneven roof lines, unlevel floors, or leaning walls. If differential settlement continues and is not remedied, it will eventually cause damage to the structure above the foundation.

Site Drainage

Run-off and rainfall should be directed away from structures in order to prevent water from damaging the foundation system and to prevent water from entering the structure. To aid in this, ground slopes adjacent to a building should slope away from the structure. Inadequate ground slopes can result in excessive moisture in the soil around the foundation.

In order to prevent water from damaging the foundation system or entering a building, the ground surface adjacent to a building should slope away from the building. The *International Residential Code* (IRC) and good construction practices require a minimum of a 6-inch vertical drop in 10 feet of horizontal length around building foundations.³ This equates to a 5-percent slope away from the structure. Good construction practices also dictate that impervious surfaces within 10 feet of the building foundation slope away at a minimum of 2 percent.

Conclusions

Concrete slab cracks greater than ½ inch wide and that are vertically offset on opposing edges, unlevel floors, and diagonal cracks in wall finish surfaces are caused by differential movement of the supporting soil. Soil that is exposed to excessive moisture has an increased potential to settle differentially when compared to soil that is exposed to excessive moisture. Moisture content readings on the ceiling, and leak detection testing results, indicate that excessive moisture from a roof or plumbing leak do not contribute to differential settlement. The absence of gutters near the northwest corner and grade slope readings are evidence that inadequate drainage in the area worsens differential settlement. The displaced

³ *International Residential Code for One and Two-Family Dwellings*, Section 401.3

floor is caused by differential settlement of supporting soil which is worsened by inadequate site drainage.

Summary of Conclusions

In summary, based on what is known at this time, I am of the opinion that:


- The displaced floor is caused by differential settlement of supporting soil which is worsened by inadequate site drainage.

This report is based on information known to Donan at the time the report is issued. Donan reserves the right to amend or supplement this report if additional relevant information becomes available.

If you have any questions or concerns, or need additional assistance on this project, please email donan@donan.com, as this will ensure a prompt response to your request. We appreciate your confidence in our professional services.

Sincerely,

DONAN ENGINEERING CO., INC.

A handwritten signature in dark ink, appearing to read 'Michael Drinkwater', with a stylized, flowing script.

Michael Drinkwater, P.E.
Forensic Engineer
Arizona P.E.: 62712
Expires: September 30, 2022



Photograph 1: The west (front) side.



Photograph 2: The north side.



Photograph 3: The east side.



Photograph 4: The south side.



Photograph 5: The northwest bedroom.



Photograph 6: The crack in the northwest bedroom floor slab.



Photograph 7: The cracks has sharp, bright edges.



Photograph 8: The crack in the bedroom south of the northwest bedroom.



Photograph 9: The crack in the bedroom south of the northwest bedroom.



Photograph 10: The baseboard on the east side of the crack.



Photograph 11: The baseboard at the northwest corner.



Photograph 12: A slope reading on the east side of the crack.



Photograph 13: A slope reading on the west side of the crack.



Photograph 14: A slope reading on the west side of the crack.



Photograph 15: A slope reading at the top of the window on the west wall.



Photograph 16: A stain on the ceiling at the northwest corner.



Photograph 17: A comparative moisture reading on the stain.



Photograph 18: The north end of the west side.



Photograph 19: A grade slope reading near the north end of the west side.



Photograph 20: A crack in stucco that extends from the corner of a window opening.



Photograph 21: A grade slope reading near the west end of the north side.



Photograph 22: A diagonal crack extends from the corner of a window opening.



Photograph 23: The crack has rounded edges and is surrounded by paint that does not match the prevailing surface.



Photograph 24: The water meter at the beginning of the leak test.



Photograph 25: The water meter at the end of the 28 minute leak test.