



Home Builders' Perfect Storm

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Catastrophic Structural Failure Case Histories

A Perfect Storm is defined as “an event in which a rare combination of circumstances drastically aggravates the event.” Home builders all too commonly are lulled into a warm sunny skies mentality, only to find themselves in the dark, spiraling grasp of a perfect storm. We queried the nation’s largest database of forensic structural claim investigations to profile three such builders. Herein lie their stories, and the critical lessons learned.

Unparalleled Disaster in a Picturesque New Mexico Master Planned Community

A visit to this community in 2005, as construction began on 300 single-family homes, would reveal no visual hint of the geologic hazard that would seriously disrupt the lives of so many homeowners. No hint of the pending foundation failures, snake-like cracking, sloped floors and racked doors. No hint of the army of insurance adjusters, engineers, foundation repair contractors, attorneys and news reporters that would descend on this peaceful community.

The property looked perfectly normal. The topography was flat, no water features, no areas built up with fill material, no large rock and the soils were firm. But as is often the case with geologic hazards, what you can see is not the problem. The problem is what you can’t see lurking beneath the surface.

In this case, the developer properly conducted a geotechnical investigation to explore beneath the surface, and provided the geotechnical report to the builders. The investigation indicated that the soils consisted of silty fine sand. The sand was very dry. Groundwater was not found. The density of the sand was low, indicating that there were an abundance of tiny air voids between sand grains.

The most important finding of the investigation was that the dry sandy soils were found to be “collapsible.” Collapsible soils are defined as “unsaturated soils that can withstand relatively high pressure without showing significant change in volume; however, upon wetting they are susceptible to a large and sudden reduction in volume.” Collapsible soils are a geologic hazard found mostly in the

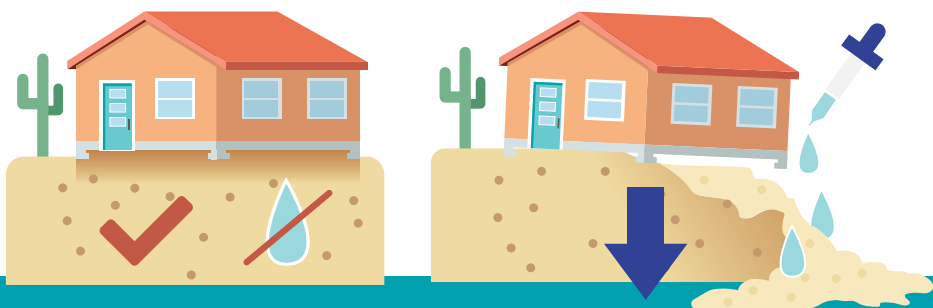
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The geotechnical report indicated that there was an average 3% collapse potential of the soils. That means if the soils are wetted they could suddenly collapse (settle) one-third of an inch per foot of depth, or 4 inches in the upper 10 feet. Unfortunately, the shallow spread footing foundations used at this community could only safely tolerate about 1 inch of settlement.

Due to the collapsible soils, the geotechnical engineer rightfully recommended several best practices to keep the soils from collapsing and causing damaging settlement.

These recommendations included:

1. Design well-reinforced foundations to tolerate potential movement
2. Moisture condition and properly compact foundation support soils and any structural fill material
3. Install gutters, downspouts and splash blocks
4. Grade lots to create rapid runoff of rainwater
5. Irrigate only minimally, and no irrigation within 5 feet of the foundation
6. Provide engineering oversight during construction to confirm these recommendations



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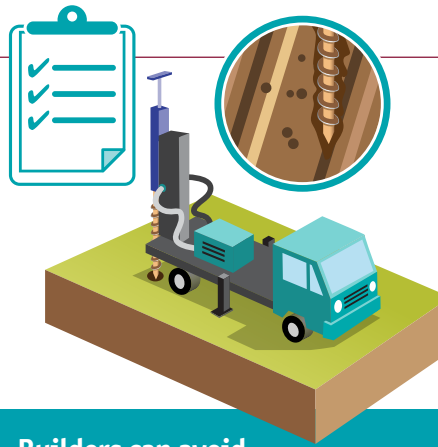
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Considering all these proper engineering recommendations for collapsible soils, you might wonder why almost 80 foundations experienced settlement-related failure to date? The answer is that these recommendations were not consistently followed by the builders, contractors and homeowners. This is despite multiple warnings in the geotechnical report that if the soils are wetted, "significant structural settlement and distress may occur."

When the perfect storm passed, one national and one regional builder that primarily developed this phase of the community suffered different consequences. The national, self-insured builder reportedly faced claims and related expenses from at least 40 homeowners. Many homes had to be bought back. The regional builder was covered by a third-party, insurance-backed, new home structural warranty. The warranty company has paid over \$4 million to date for 39 claims, 21 on the same block. The ultimate losses may be well over \$5 million when all 10-year warranties have matured. Structural claims were filed an average of 6 years after homes were sold, and the average loss per home exceeded \$70,000. The regional builder had an admirable loss history before this particular community, and is still active in the warranty program.

Catastrophe in a Quiet Mississippi Subdivision

When it comes to perfect storms, a large regional builder in Mississippi thought they were taking all the necessary precautions. A portion of Mississippi is well known for an expansive-clay geologic formation. This clay formation has a characteristic bluish color and builders know its high potential to swell when wetted. The clay can swell up to 12% and exert uplift pressures of up to 6,000 pounds per square foot. This can result in home foundations being lifted well over 1 foot! Slab-on-grade foundations in the



Builders can avoid settlement-related failures by consistently following the engineer's recommendations and geotechnical report.

area are only designed to tolerate one or two inches of movement. Expansive clay soils cover over half of the United States, concentrated mostly in the central and southern states.

This particular builder typically utilized a satisfactory practice to identify this clay formation before developing a new property. The builder would either drill exploratory borings or dig test pits. Most commonly, the builder would dig test pits with a backhoe to search for this easily identifiable clay. Per local proven industry practice, if there is a buffer zone of non-expansive overburden soil with a thickness of at least 7 feet separating the expansive clay from the bottom of slab foundations, then swell-related damage is unlikely. Regrettably, for one particular

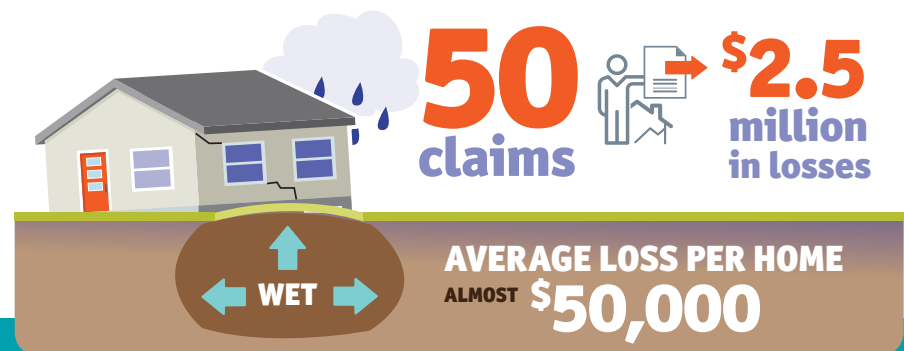
development of 170 homes, a search for the clay was omitted.

The clay was indeed present, hidden just below the bottom of the slab beam excavations. Furthermore, rainwater, often the catalyst for foundation failures, did not drain well from most lots. The result, over 50 structural claims totaling about \$2.5 million in losses. The average loss per home was almost \$50,000. Claims were filed an average of 7 years after homes were sold, since water penetration into the clay and resultant swelling occurs slowly. Before the perfect storm struck, this builder had a 17-year respectable loss record with over 1,000 new homes, and still continues to enroll homes in the warranty program.

Epic Failures in Majestic Utah Master Planned Community

Located among glorious mountain peaks in Utah lies a family-centric master planned community with stunning vistas and endless highland activities. Two regional builders acquired hundreds of lots from the developer and started construction in 2005. The builders had no obvious warnings about the devastating high-profile impact of the approaching perfect storm.

The two builders retained the services of a geotechnical engineer to explore the subsurface conditions on some,



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but not all, of the lots scattered about the community. The natural subsurface conditions were optimum for home construction. However, on many of the mountain lots, homes would not be founded directly on the natural soils. The grade on these lots was quite steep, requiring the need to import fill material to create level building pads.

Trucks hauled in a massive amount of fill material and end-dumped the fill onto the steeply sloped lots. As the fill started to rise and level the grade, the builders compacted the top several feet to create a firm building pad and started home construction.

Then it happened, completed homes started settling and experiencing significant distress just months after they were sold. This early development of distress is a telltale sign that the homes were founded on improperly compacted fill material. In fact, forensic investigations found 45 to 65 feet of improper fill thickness. As soon as the weight of the homes was applied to the fill it began to consolidate, causing up to a foot of settlement, and more to come if not stopped. Improperly compacted fill can settle up to 5% of its total thickness, which translates into almost 40 inches of worst-case settlement potential for these lots.

The geotechnical reports, if any, used by these builders all specified that any fill material bearing the load of the foundations should be properly compacted and tested. The builders' attempts to compact the deep fill with the same equipment used to spread the fill were woefully inadequate.



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As the warranty company began to receive claims soon after the homes sold, warranty company engineers were able to quickly alert the builders about the cause of the claims so that they could modify their lot development practice to avoid additional claims. For this reason, only 6 claims were received, averting a much larger disaster. The total losses were \$1.2 million. Alarming, the average loss per claim was over \$200,000! That is because fill material claims typically impact the entire foundation. The claims required full-underpin remedial piers extended through the deep fill and founded at great depth. These builders had enrolled hundreds of homes in the warranty program over many years with favorable loss histories, but as is often the case, the tall onerous dark clouds of a perfect storm were building.

Critical Lessons Learned

How could these three catastrophic case histories have been avoided?

- Use a geotechnical investigation for conditions specified by code (*see 2012 IBC 1803.5*)
- Read the entire geotechnical report, and fully comply with the engineer's recommendations
- Properly compact and test all fill material that supports the foundation (*see 2012 IBC 1803.5.8*)
- Establish proper site drainage (*see 2012 IRC 401.3 & 801.3*)
- Educate homeowners to maintain established site drainage and not over-irrigate

Despite builders' best efforts and intentions, perfect storms will happen. Some builders gamble on their journey and hope to navigate around perfect storms. Experience dictates that it is prudent to consistently embrace best construction practices, and to properly manage risk to protect company assets and hard-earned reputations.



About the author: Walt Keaveny, MS, PE, PG is the Risk and Underwriting Manager for America's leading new home warranty company, 2-10 Home Buyers Warranty. Mr. Keaveny is licensed as both a Professional Engineer and Professional Geoscientist with over 30 years of engineering and construction experience. His articles have been broadly distributed by the NAHB and local HBAs.

