Report on Foundation Investigation

For

City of Menasha

Wisconsin

April, 2007

Prepared by:

Larson
Larson Engineering, Inc
1500 North Casaloma Drive, Suite 302
Appleton, Wisconsin 54913-8219
(920) 734-9867 Fax: (920) 734-9880

Introduction

This report documents an investigation into foundation problems noted by homeowners in the City of Menasha during the past several years. The goal of the report is twofold: to evaluate the potential for similar problems in new development areas in the City, and to recommend policies for dealing with the existing issues.

Description of the Problem

Menasha is located on the north end of Lake Winnebago, in the counties of Winnebago and Calumet, in east central Wisconsin. The larger and older parts of the City are located in Winnebago County. To the south, Menasha is abutted by the City of Neenah, to the north by the City of Appleton, to the west by the Town of Menasha, and to the east by the Town of Harrison. New development areas in the City are primarily located to the east, in Calumet County.
During the past few years, increasing numbers of foundation problems have been reported by homeowners. The problems have manifested themselves in large numbers of foundation repair permits issued by the City. The problems appear to be concentrated in several distinct areas; specifically, the Carver Lane area, the Clovis Grove area, and the Depere Street area.

Field Investigations

Letters were sent to homeowners in the areas of interest, requesting feedback on observed foundation problems, and permission to inspect basements and discuss problems with residents. 125 letters were sent out and 122 responses received. Inspections were subsequently conducted at 7 buildings. The following is a summary of the findings. Photographs of some of these conditions are included in Appendix A.

723 Carver Lane. The house at 723 Carver Lane is a split level with partial basement of concrete masonry units and a crawlspace under the front of the house. It is approximately 60 years old. The basement slab was cracked, as were the concrete block walls. The owner further noted that settlement and wall movement problems had occurred over the years. At the time of the inspection, the owner was in the middle of a repair project to arrest settlement of the foundation in the rear of the house (the basement area). The repair consisted of pouring a 30-inch wide concrete footing under the existing footing and pouring a new concrete basement wall outside the existing wall, knitting the walls together by means of blockouts in the masonry. A drain tile line has been installed in the back yard to provide drainage of the relatively flat yard. Noticeable settlement and movement was also observed in the garage, and in other houses on Carver Lane.

1112-1122 Woodland Drive. One of these three duplexes (all owned by the same landlord) was inspected; the owner indicated that all three have similar problems. The buildings are 22 to 24 years old. Problems observed include cracking of the basement slab, horizontal movement of the concrete masonry unit sump crock, drywall cracking at doors, and settlement of the ground around the foundation. The concrete driveway slab has cracked and settled; the owner has had the slabs mudjacked and additional settlement has occurred since then, pulling the slab away from the stoops. The owner has filled in low areas to drive runoff away from the foundation. The backyard of these buildings is low and poorly drained; it collects runoff from the adjoining houses to the west and ponding occurs during heavy rains.
Across Woodland Drive to the east, the homeowner at 1105 Woodland was having repair work done to his concrete block basement wall. He has been a resident at that location for 28 years and had not

experienced problems until the past 2-3 years. The new work consists of vertical steel piers installed inside the basement wall, anchored to the floor slab at the bottom and the wooden joists above, to resist any inward pressure put on the wall.

1048 Alva Drive. The owner of this house reported that two foundation repair projects had been completed during the time she lived there. In 1989-90, three vertical steel piers were installed along the north end of the front (east) wall, in response to diagonal cracking and movement of the front wall. In 2004, the earth along the north side of the house was excavated and the hole backfilled with gravel to provide proper drainage and relieve pressure on the wall. A crack in the basement wall was also patched at this time, and it had reopened in 2006. During the summer of 2006, she noted the front door jamming, and a diagonal crack developed at the south end of the front wall. This crack was slightly open (1/8" to 3/16") and there was some displacement at the crack.

632 12th Street. The house at 632 12th Street is about 30 years old, and the current owner has lived in the house since 1993. No problems with the foundation were noted until 2004, when movement of the back (north) basement wall caused damage to the finished ceiling. At that time, 6 wall anchors were installed on this wall to pull it back into proper alignment and prevent further movement, and 8 anchors were installed along the west wall. A series of cracks have developed in the basement slab. Due to continued movement of the walls, jamming of doors and drywall cracking, the owner had push piers installed along the north and west walls in fall of 2005. Further movement and damage has occurred during 2006, resulting in misaligned doors and a separation of the stone veneer on the front exterior of the house.

1226 Darlene Street. This 28 year old house has experienced foundation wall movement resulting in substantial cracking. The house is a split level with basement in front; the foundation walls are poured concrete. The current owner, who has resided at this address for about one year, has heard snapping noises as cracks propagated though the foundation walls. A series of cracks at fairly regular intervals, about 16 feet, was noted along the west wall of the house. A heave was observed in the floor slab near the back center of the basement, with a displacement of about 1/2-inch. According to the owner, all of the foundation cracking and movement had occurred within the four months preceding the inspection in September of 2006. A new stoop was constructed in 2005; it had been wobbly during the summer of 2006 until it rained in late summer. Some spider cracking of the ground surface was observed north of the house during the inspection – this is often observed in desiccated clay soils near the ground surface.

Supporting Information

A. Shrink-Swell Characteristics of Soil.

Certain clay soils exhibit volume changes as a result of changes in moisture content. These soils are referred to as expansive soils, and are characterized by medium to high plasticity and low moisture content. They may have high amounts of a mineral called montmorillinite, which in its pure form is used to seal boreholes and wells due to its tendency to expand in the presence of water.

Soils in the affected areas have been cataloged by the USDA in the County Soil Surveys. The survey maps for the three locations under discussion are attached in Appendix B, along with the map for the entire City of Menasha east of Little Lake Butte des Morts. The soil in the Carver Lane area is identified as Winneconne silty clay loam, while the Clovis Grove soils are Neenah silty clay loam. In the Depere Street area both Winneconne and Neenah soils are identified. While both of these silty clay loam soils are common in east central Wisconsin, variations within the soil association are to be expected.

Linear extensibility is the measure of the change of length of a soil specimen as the moisture content

changes. It is expressed as a percent of the original specimen length. The Neenah and Winneconne silty clay loam soils in the affected areas have a linear extensibility rating of 7.1, which places them in the high category (low, moderate, high, very high). The degree to which this expansiveness will damage a structure also depends on other factors such as surcharge pressures and the arrangement of the structure and soil. Note that this expansion can be vertical as well as horizontal.

B. Settlement.

A number of factors can result in excessive settlement of structures. Soils naturally consolidate when pressure is applied to a mass of earth, such as results from the construction of a building. Settlement up to an inch is not unusual for houses or light commercial structures. Settlement can also be caused by groundwater extraction, vibration from seismic activity or machinery, decomposition of underlying organic materials, karst activity (see below), settlement of fill, and any combination of these factors. Settlement of deep fills can also have a lateral component.

The foundation problems observed at some of the inspected sites appear to be settlement related. As the foundation settles, stresses in the basement walls are redistributed to stiffer areas, and the structure no longer acts as it was designed. Cracking and shifting of walls, jamming of doors and windows, and cracking of slabs are indications of settlement.

C. Potential Karst Geology.

Karst topography occurs in areas underlain by limestone or dolomite bedrock. Limestone and dolomite, which contain calcium carbonate and calcium magnesium carbonate respectively, are susceptible to solution by groundwater or runoff, which is often slightly acidic as a result of falling through the atmosphere. The movement of water through crevices and pores in the bedrock carries away the mineral constituents of the stone itself, and results in the creation of caverns and sinkholes, which form when the overlying soils collapse into the voids in the rock. Modest sized sinkholes can be seen at High Cliff State Park, across Lake Winnebago from Menasha.

Bedrock in the Menasha area is identified as the Sinipee Group, a dolomite with some limestone and shale, of the Ordovician period. There do not appear to be any documented karst features in the project area.

D. Precipitation Data.

Because the clay soils in the affected areas are sensitive to moisture content, a brief examination of recent precipitation data is in order. Monthly rainfall data for northeast Wisconsin was obtained from the National Oceanic and Atmospheric Administration. Total rainfall during the months of June, July, and August averages 11.74 inches for the period 1901-2000, with a range from 6.5 inches to 15.8 inches. For each of the years 2003 to 2006, summer rainfall totals have been below this long-term average. The total precipitation deficit for these four summers is about seven inches, with the largest single deficit occurring in 2003.

Conclusions

The predominance of moisture sensitive soils in the areas with high incidence of foundation problems, together with the series of dry summers experienced recently, suggests that the primary cause of the increase in foundation distress reports is shrink-swell activity of the soil. Because soil moisture changes for clay soils happen rather slowly, it likely takes more than one year of sub-average precipitation for drying to take place to sufficient depth to cause the types of problems observed recently.

Recommendations

A. New Construction.

Most new residential construction in the City of Menasha will be occurring in Calumet County in the coming years, in an area between Oneida Street and Lake Park Road. Examination of the soil survey mapping for this area indicates that only a small portion of the area is characterized by soils with high or very high ratings for linear extensibility. It should be noted, however, that the soil survey generally represents the upper 60 inches of the soil mass, and therefore it is possible that clayey soils underlie the loamy soils indicated by the survey.

Soil borings for the proposed Menasha Fire Station at Manitowoc Road and Providence Terrace were reviewed and they did indicate that clay soils are present. The samples that were tested were classified as lean clay, while the expansive soils tend to be fat clays.

Given this information, the proposed development areas appear to be suitable for buildings with basements, provided some basic good practices are followed.

- Good drainage is critical. Drainage plans prepared for each subdivision should be implemented fully. Compliance with the drainage plan should be verified by field checking building and lot elevations. Verify positive drainage away from the basement walls.
- Foundation walls should be backfilled with granular material (clean sand or gravel). Clay soils must not be used adjacent to basement walls.
- Foundation drains should be installed and backfilled with clear stone for every basement.
- The basement excavation should be inspected before footings or gravel work pads are placed, to look for soft areas which may produce excessive settlement. Soft areas can be over-excavated and backfilled with stone or lean concrete. Pocket penetrometer tests can be quickly and easily performed by the building inspectors.
- Clay dams or plugs should be installed in utility trenches leading to the foundation, to reduce migration of high groundwater to the building.
- A bias for reinforced concrete or grouted reinforced CMU walls will provide an additional measure of protection. The City may be limited in its ability to require reinforcing, however.

B. Existing Construction

Problems with existing foundations are more difficult to address. City involvement is generally limited to issuance of a building permit, and little or no inspection is done. Some of the systems used for foundation repair are proprietary and rely on the experience and qualifications of the installer, both for selection of the proper systems and to ensure correct installation. Some examples of these systems are included in Appendix C. Both of these particular systems require careful use, as their efficacy can be affected by the site specific soil conditions. As an example, the wall anchors will tie the basement walls to the surrounding soil mass, and hence any shrinkage of the soil mass will pull the walls out of alignment, potentially causing more damage. The use of wall anchors for permanent wall support should be limited to areas where expansive or sensitive soils are not present. This should be verified by a qualified professional.

Most of the recommendations for new construction will also serve well for existing construction. Free-draining backfill, functioning foundation drains, and good surface drainage are always appropriate requirements.