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DE-ERECTION OF STEEL FRAMED STRUCTURE DUE TO EXCESSIVE SETTLEMENT

A manufacturing building was proposed in Wisconsin as an addition onto another manufacturing building. The structure was to be placed immediately to the east of the existing building. The structure to be constructed was a 360 ft. by 380 ft., 40 ft. high column supported steel structure (see Figure 1). In order to bring this metal building above flooding limits, the building pad was raised by placing sandy fill from 14 ft. thick in the southeast to 11 ft. toward the northwest corner.

Whereas the existing building sat on significant sand deposits, the proposed structure to the east was situated in compressible glacial and post-glacial lake sediments. Note the upper post-glacial sediments appear to be significantly more compressible than the older sediment. An approximate northwest-southeast geologic cross-section through the proposed building is shown in Figure 2. This cross-section shows that there is about a 50 ft. thick zone of mainly soft fine grained sediments with the southeast corner of the building pad containing about 17 ft. of the more compressible later lake sediments compared to less than 9 ft. on the northwest corner (see Figure 2).

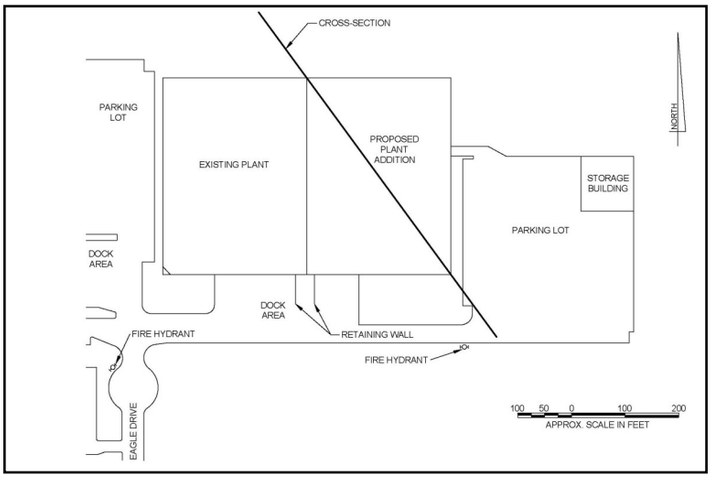

FIGURE 1 BUILDING PLAN

From the subsurface design investigation of the site, the presence of the compressible sediments was recognized. As a result, the engineer recommended pre-compression of the underlying sediments by the early placement of the building fill and by the stockpiling of fill on top of the building (permanent) fill (i.e. surcharging). The stockpile fill was designed to be placed in a building pad area until the settlement of the stockpile was deemed to sufficiently compress the subjacent soils. The stockpile was then moved to compress another building pad area (aka rolling surcharge). See Figure 3. After surcharging the site with 50 ft. x 50 ft. test stockpile this method was determined to be feasible with a 10-15 ft. high stockpile.

After the building was constructed, the structure continued to settle resulting in damage which gradually worsened. After about 4 years, the damage was so severe that the building was considered structurally unsafe to occupy as a result of overstressed-failed steel members. The differential settlement in the southern portion of the building at about this time is shown in Figure 4. As can be

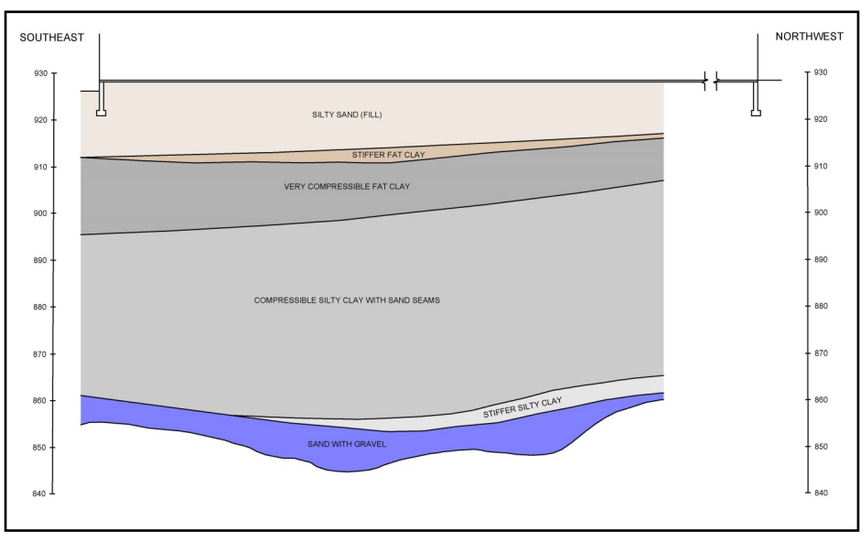

FIGURE 2 SUBSURFACE CROSS-SECTION

seen in Figure 4, over 1.4 ft. of differential settlement had occurred in the southeast corner of the building with a maximum floor slope of 10 percent (and a maximum angular distortion 1/75 over 80 ft.). There were also floor flatness issues.

Because of the unsafe structural condition, other damage and that another up to 1 ft. of future movement was expected the building was dismantled. A photograph of the removed structure to the floor slab is shown in Figure 5.

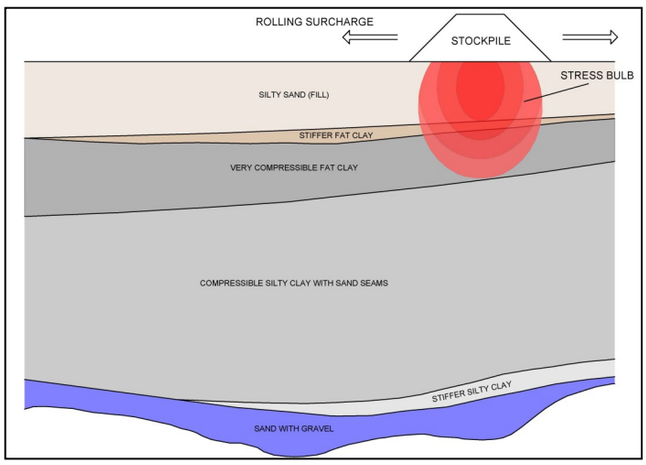

FIGURE 3 ROLLING SURCHARGE ILLUSTRA-

The cause of the excessive settlement was the result of the under-compressed subsoils especially in the southeast corner of the building pad. This resulted from an under-appreciation of how deep the compressible soils were (note design borings were not extended to bottom of soft soils at depths of 50-60 ft. and inadequate surcharging). The rolling surcharge loads were not sustained long enough nor wide enough to load deeper soils (see Figure 3) and were of insufficient coverage (especially in the southeast corner).

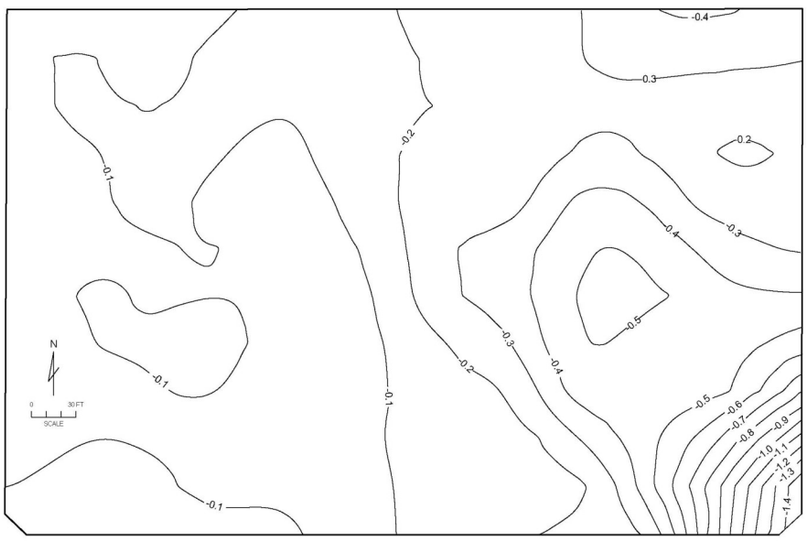

FIGURE 4 BUILDING SETTLEMENT CONTOURS STRUCTURE

LESSONS LEARNED

When considering pre-compressing thick, soft to very soft clay soils with a rolling surcharge, detailed and well thought out specifications should be developed and field executed (e.g. minimum stockpile size, surcharge completion criteria, stockpile movement criteria, and stockpile slope stability requirements). Ground improvement by rolling surcharge can result in an extended amount of time compared to fully surcharging the site with the use of installed vertical wick or sand drains to expedite the porewater drainage of the saturated clay during compression.

FIGURE 5 SOUTH VIEW OF DISMANTLED STRUCTURE

Other MEA Publications that may be of Interest:

UPDATE #11: Frozen Fill Causes Building Damage

UPDATE #13: Foundation Recommendations Result in Unnecessary Large Cost

UPDATE #37: 500 Ft. Assembly Platform on Concrete Piers Heaves

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FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact MEA at the address listed below.

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