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CDM Jessberger

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January 17, 2001

Mr. Anthony Ordway
CertainTeed Roofing Products Group
6350 N.W. Front Avenue
Portland, Oregon 97210

2423/4

Subject: Mat Foundation Recommendations
Plant Building Improvements
CertainTeed Roofing Products
6350 N.W. Front Avenue
Portland, Oregon

01-13589-Q

Dear Mr. Ordway:

Camp Dresser and McKee Inc. (CDM) is pleased to present additional recommendations for a mat foundation at the CertainTeed Roofing Products plant in Portland, Oregon. Mat foundation recommendations were requested by Mr. Robert Chi, P.E. of RW Cooper and Associates.

Background Information

As you are aware, CDM performed a geotechnical investigation and issued a report dated November 13, 2000 for the compartment bin at the plant. One boring was drilled at the proposed bin location. Recommendations for deep foundations were presented in our report, because the structural engineer was concerned about settlement during an earthquake. Because ground conditions are generally favorable, spread footings are now being considered for support instead of piles. Static loads on the four bin columns will range from 51 to 70 kips on each column. Additional seismic loads will range from 30 to 50 kips at each column. Mr. Chi also requested our review of the liquefaction potential and the dynamic "site factor".

The recommendations presented in this letter are based on the subsurface data obtained during our November, 2000 investigation. No additional subsurface investigations or laboratory testing was conducted.

Seismic/Liquefaction

A site specific seismic evaluation was not performed for this study Our earlier conclusions regarding seismic considerations were based on the Relative Earthquake Hazard Map of the Portland Metro Region (DOGAMI IMS-1) and our past experience in the area.

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Liquefaction, or the loss of shear strength, can occur in loose saturated sands and some fine-grained soils during an earthquake. Plastic silts and clays usually do not liquefy. Liquefaction commonly occurs in geologically young alluvial or fill soils. Evidence of liquefaction commonly includes "sand boils" at the surface, an increase in soil density and a corresponding decrease in volume manifested by surface subsidence. Liquefaction may be widespread or localized in extent.

The liquefaction potential of the sand soils was evaluated using the simplified method developed by Seed and Idriss. This method is based on observations of liquefied and non-liquefied sites and site characteristics which can be easily determined, such as SPT data and fines content. A cyclic resistance ratio (CRR) of the soil is determined from the empirical Seed and Idriss data for a given SPT and fines content. The cyclic stress ratio (CSR) produced by the design earthquakes was calculated using the peak ground accelerations produced from the UBC for soil type S_D. Liquefaction is anticipated if the earthquake induced CSR is greater than the CRR for the soil.

The results of our analysis indicate that the same layers assumed liquefiable in our November report are liquefiable. Because the site is mantled with about 12 feet of unsaturated sand fill, we do not anticipate that surface manifestations such as sand boils or loss of bearing capacity will occur. Based on the Ishihara and Yoshimine chart for estimating volumetric strain, we estimate that liquefaction will result in approximately 5.5 to 6 inches of settlement within the liquefied zones.

Spread Footings

The proposed bin may be supported on conventional spread footings. Mr. Chi has indicated two possible options for the spread footing support, either four individual spread footings or a mat foundation that supports all four columns.

Our analyses of 6-foot by 6-foot isolated spread footings at the four columns indicated settlements on the order of 0.3 inches for the dead loads and 0.5 inches for dead loads plus seismic. These settlements are reasonable and normally acceptable under static and dynamic conditions.

As indicated above, liquefaction is predicted for the design earthquake and 5.5 to 6 inches of settlement is expected within the liquefied zones. If widespread liquefaction occurs, the entire ground surface would settle 5.5 to 6 inches and no differential settlement would occur between the new facility and the existing plant site. However, liquefaction is most likely to occur over localized areas. If so, the surface manifestation of the settlement will be moderated significantly by the intervening soil layers that do not liquefy and by the surficial 12 feet of soil above the groundwater table that does not liquefy. Maximum differential settlements could be moderated to one to two inches. In our opinion, the mat

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foundation option would address that minor differential settlement problem by tying together all four columns and minimizing the differential settlement between the new structure and the existing facility. We recommend the mat foundation as a reasonable accommodation of the modest liquefaction.

Mat settlements were analyzed with the proposed loads assuming a flexible mat (see Figure 1). A rigid mat is approximated by settlements that average the corner and center settlements. For average mat loads of about 0.4 tsf, settlements are estimated at 0.22 inches.

The mat foundation will result in settlement of the adjacent existing column footings similar to those beneath the mat.

Lateral loads on the mat foundation may be resisted by friction between the mat and the underlying sand fill, and by passive earth pressure on the face of the mat. The ultimate passive resistance of compacted, level backfill may be assumed equal to a 350 pcf equivalent fluid pressure for both the static and dynamic condition. A friction coefficient of 0.40 may be used for the mat bearing on the sand fill.

UBC Site Factor

The UBC defines soil type S_D as having an average SPT blow count between 15 and 50 blows per foot in the upper 100 feet. The average blow count for the 71.5-foot boring is well above 15 bpf. Therefore, based on SPT blow count criteria, the soil type at the site is classified as S_D.

UBC states that liquefiable soils are classified as type S_F. Because the site is mantled with 12 feet of non-liquefiable soils, surface manifestations of liquefaction will be non-existent or greatly reduced. Therefore, it is our opinion that UBC soil type S_D is the most appropriate for the site.

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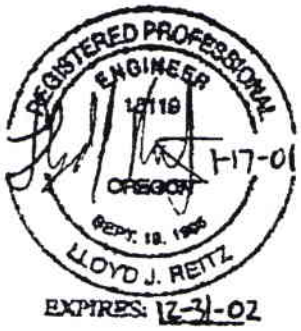
We trust that this information meets your needs at this time. We would be pleased to provide additional input, as necessary, during the design process and to provide on-site observations during construction. If you have any questions, please contact us.

Very truly yours,

CAMP DRESSER & McKEE INC.



Lloyd J. Reitz, P.E.
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LJR/RJS

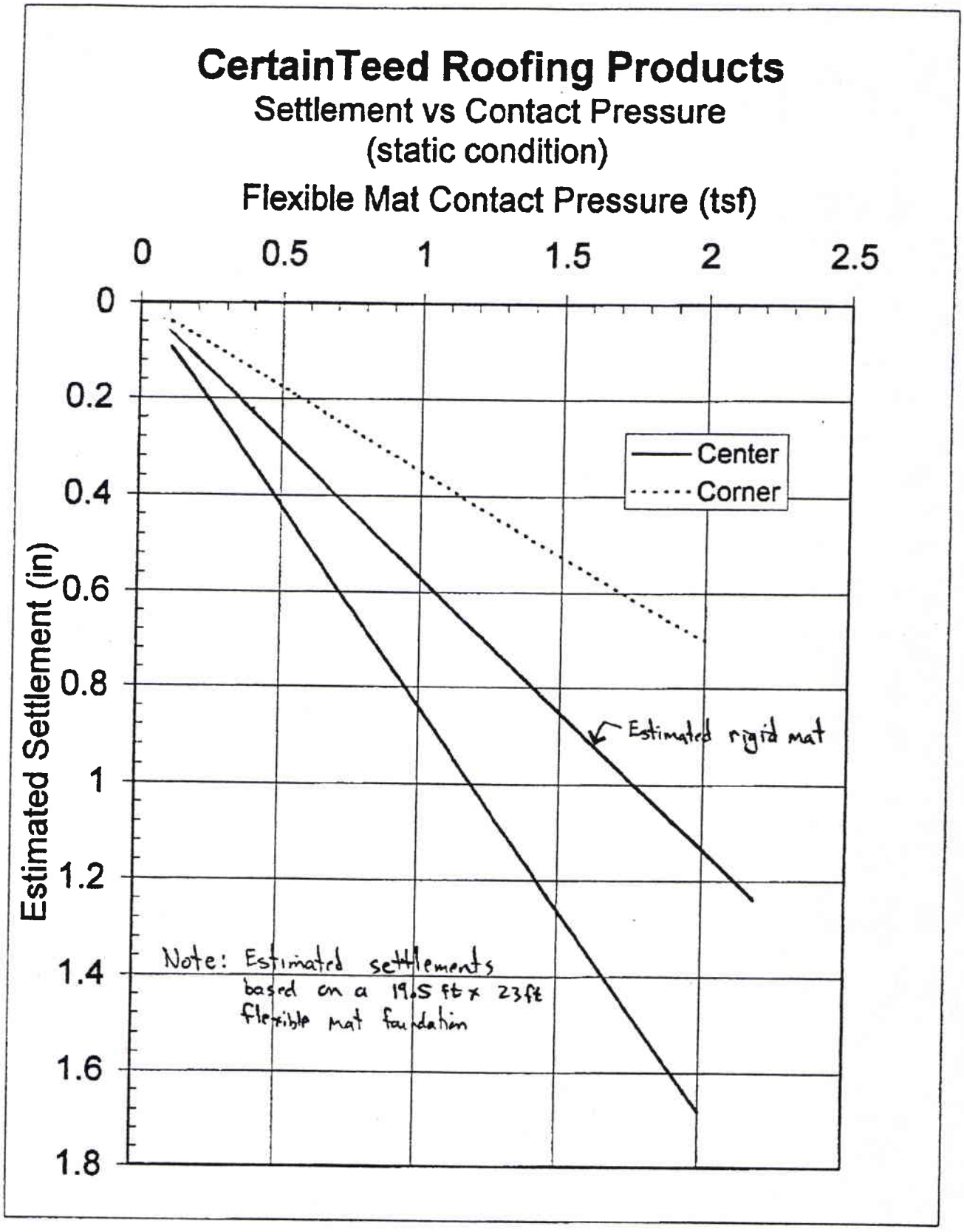
CertainTeed Roofing Products
Settlement vs Contact Pressure
(static condition)
Flexible Mat Contact Pressure (tsf)
0
0.5
1
1.5
2
2.5
Estimated Settlement (in)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
Center
Corner
Estimated rigid mat
Note: Estimated settlements based on a 19.5 ft x 23ft flexible mat foundation

Figure 1