LIGO-C970547-00-D

Mr. Fred Asiri
LIGO Project
California Institute of Technology
102-33 Bridge laboratory
Pasadena, California 91125

DRAFT

Re: Geotechnical investigation of Dikes
WCC File No. 94B315

Dear Mr. Asiri:

We have completed the sampling and consolidation testing of dikes and corner station fill materials as directed by you. The scope of this activity was to perform undisturbed sampling at six predetermined locations on each dike of the LIGO facility at Livingston, Louisiana and perform tests to estimate the potential for consolidation of soils forming the dikes. Additionally we were requested to sample and perform consolidation tests for two predetermined locations at the corner station.

Please find below a brief description of the work completed and a discussion of the results.

Sampling and Sample Selection:

On March 24, 1997, we began the undisturbed sampling operations with a drill rig mounted on an all terrain vehicle (ATV). The site conditions and the weather prediction of an 80% rain (it did not materialize) for the evening of March 24 compelled us to use the ATV to meet the schedule for our deliverables.

As per our earlier discussions, to avoid areas disturbed by prior sampling operations, the boreholes were located near, but not exactly at, stations tested by Delta Testing Laboratories on March 10, 1997.

Continuous samples were obtained through the full depth of the dikes with some extension into the natural ground. Field observations indicated that soil types at a given location varied considerably with depth. In place materials were observed to be non-homogeneous. Visual identification of the samples in the laboratory verified the latter observation.

Field moisture content and density of selected samples were determined in the laboratory prior to other testing. Specimens for consolidation testing were selected based on their visual soil classification (i.e., clay vs. silt), density (i.e., low vs. high density), field moisture (i.e., high vs. low) and depth (i.e., near surface samples were avoided).

Samples obtained from the South-East (S/E) dike appeared to have larger variations in density and soil types thus testing was concentrated mainly on specimens selected from samples taken from there. One sample obtained from below the subgrade of the S/W Station 33+00, where the dike is shallow, appeared to have high clay and moisture contents, it was also selected for testing.

Consolidation tests as per ASTM D 2435 were performed starting with a load increment of 1/2 ton/sq.ft and continuing until primary and long term consolidation under 4 tons/sq.ft was completed.

The moisture content, density and percent saturation of each specimen were measured and computed both prior to and upon completion of consolidation tests.

Discussion of Test Results:

Visual observation of all samples showed that soil types and the associated moisture contents, within the profile of the dike at tested locations, varied considerably (see attached logs of borings).

The degree of saturation of undisturbed samples prior to testing varied from 92 % to 98 %. The moisture contents of specimens were 4% to 9% above the optimums and densities were 6% to, 12% below maximums as determined by Delta Testing Laboratories. Specimens upon submergence in the consolidometer, under initial load increments, appeared to be taking water. As specimens were subjected to additional load increments they approached 100% saturation as a result of consolidation. It should be noted here that to obtain the full spectrum of loading conditions each specimen was subjected to loads (4tons/sq.ft.) far exceeding the expected dead loads that the dikes will be expected to support.

For the purpose of estimating the consolidation of the dikes we assumed (exclusive of subgrade settlement) an average unit wet weight of 120 lb/cu.ft. for the compacted soils. A maximum total load of 1,000.00 lb/sq.ft. was assigned to the slab, tunnel, tunnel cover and associated hardware (Table 1).

Consolidation test results showed that five out of seven samples obtained from the dikes showed preconsolidation pressures averaging slightly above 1,300 lb/sq.ft. In other words five out of the seven locations had received the similar compactive effort resulting in relatively uniform preconsolidation. Two of the samples (S/E Sta. 128+00 and S/W Sta. 33+00) exhibited lower preconsolidation pressures. They might not have been subjected to the same compactive effort.

The preconsolidation pressures of six out of the seven specimens were computed to be equivalent to loads exceeding the estimated dead loads exerted by the dikes. The specimen from S/E Station 128+00 was underconsolidated and may under the load of the dike continue subsiding. However the amount of this consolidation is expected to be in the order of a fraction of an inch.

Estimated consolidation under expected dead loads for the tested locations vary from a maximum of 1.30 in. for S/E Station 128+00, to a negligible 0.1 in. (due to it's low height) for S/W Station 33+00. We should note that the specimen tested for the latter station was not part of the dike specimen it was from a sample obtained from 0.4 ft. to 1.4 ft. below the theoretical bottom of the dike. We tested this specimen because it appeared to be wet and relatively soft. For the purpose of determining settlement for this particular station we assumed a theoretical height of 4 ft. for the dike.

Test results also indicate that because of variations in soil types, moisture contents and apparent relative densities some subsidence due to periodic desiccation may take place. It is estimated that for dike sections having eight to ten feet height and an abundance of clayey soils (worst case) such incremental subsidence will not exceed 3/4 inch.

In summary the test results indicate that consolidation of the tested areas of the S/E dike due to estimated dead loads will not exceed 1.30 in. with an average of about 0.6 in. It is estimated that 90% of the consolidation due to the incremental loads will take place during the construction.

Soils within the dikes are not homogeneous, there are obvious variations in expected consolidation due to differing densities at different locations, varying heights of the dikes, and varying soil types. Thus differential settlements along the dikes should be expected. If the small number of samples tested are indicative of the general condition of the dikes, the maximum expected differential settlement due to dead loads should not exceed 1.3 inches. If subsidence due to desiccation as estimated above also takes place total differential settlement may be as much as 2.0 inches (worst case scenario).

At the time of the preparation of this report we had not been advised of the type and weight of the paving train to be used by the contractor to lay the slabs over the dikes. It is imperative for the contractor to assure that the dike as is constructed can support the paving train with only negligible vertical displacement along each dike. Since there are differences in densities, soil types, etc. it will be advisable to proof roll the entire length of both dikes using a 50 ton rubber tire vehicle (i.e. roller) to identify softer spots and take corrective action prior to beginning of the paving operations.. Only four of the wheels should be in contact with the ground and they should be capable of exerting a minimum of 150 psi (all tires) contact pressure. The proof rolling should be done under the supervision of a qualified engineer.

The above is a summary of our findings. If you have any questions please call us.

Sincerely

Robert A. SeGall, P.E.

Ara Arman, P.E., P.L.S.

TABLE 1

Woodward-Clyde Consultants

Project Notes

Subject: LSGO - Subsidance

By: D. Dimny

Dept:

Date: 04/01/-04/02/97
Project Name: LSGO
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Sta. Dyke	Dead* Load Emb.	Dead Load Slab, etc.	Total Est. P lb/□'	% Strain	Embank. Subsidence in.	Pc Preconsol. lb/□'
S/E 8+00	576	1,000	1,576	0.6	0.35	1,300
S/E 33+00	504	1,000	1,504	0.5	0.25	1,300
S/E 58+00	696	1,000	1,696	0.4	0.28	1,500
S/E 83+00	948	1,000	1,948	0.3	0.28	1,400
S/E 108+00	1,140	1,000	2,140	1.0	1.14	1,000
S/E 128+00	1,020	1,000	2,020	1.3	1.33	700
S/W 33+00	*480	*1,000	1,480	0.25	0.12	1,200

Assume Soil γ = 120 #/cu. ft. (wet)

*Assume column of soil at Sta. S/W 33+00 subjected to settlement 48 in.