TO: Client

FROM: Zach Gutierrez

DATE: September 29, 2006

SUBJECT: Masonry Lab 2

Client,

Recently we had the opportunity to execute flat jack testing on a brick wall located on the north side of the old Anthropology Building. The first part of the testing procedure was to prepare the wall for the flat jack test. To do this, one must apply disks to the masonry wall by drilling into the bricks. Epoxy the disks into the holes such that the disks are 8 inches apart. The disks must also be lined up vertically. For the axial stress part of the flat jack testing procedure, there must be a horizontal cut made in the bed joint between the two disks that is large enough to accommodate the flat jack. For the deformation test, there must be a horizontal cut above the top disk and below the bottom disk in the bed joint. Now we are ready to conduct our flat jack test.

For the axial stress test, place the flat jack into the cut, and attach lines from the flat jack to the hydraulic pump. After filling up the pump with water, place the deflection gage into the center of each disk and zero it. Pump the pump up to 150 psi, and record the resulting deflection. Then pump up the pressure in increments of 50 psi, recording each reading of resulting deflection. The deformation test will follow the previous testing procedure. However, there will be two flat jacks, one for each cut. Then repoint the cuts with type N Mortar.

The tests for both axial stress and deflection were conducted three times to get the most accurate data possible. After conducting both of the tests, we recorded the data found in Tables 1 and 2.

Table 1. Table Showing Measured data from axial stress test.								
Group 1			Group 2			Group 3		
Stress	Measured Length	Length between points	Stress	Measured Length	Length between points	Stress	Measured Length	Length between points
(psi)	(inches)	(inches)	(psi)	(inches)	(inches)	(psi)	(inches)	(inches)
0	0.2722	8	0	0.2722	8	0	0.2722	8
150	0.2746	7.9976	150	0.274	7.9982	150	0.274	7.9982
200	0.2737	7.9985	200	0.273	7.9992	200	0.2724	7.9998
250	0.2725	7.9997	250	0.2718	8.0004	250	0.2717	8.0005
300	0.271	8.0012	300	0.2706	8.0016	300	0.2697	8.0025
350	0.2698	8.0024	350	0.2693	8.0029	350	0.2685	8.0037
400	0.2684	8.0038	400	0.2678	8.0044	400	0.2669	8.0053
450	0.2669	8.0053	450	0.2663	8.0059	450	0.2651	8.0071
500	0.2659	8.0063	500	0.2647	8.0075	500	0.2638	8.0084
550	0.2645	8.0077	550	0.2634	8.0088	550	0.2624	8.0098
600	0.2633	8.0089	600	0.2617	8.0105	600	0.2603	8.0119
650	0.2618	8.0104	650	0.2606	8.0116	650	0.2592	8.013
700	0.2606	8.0116	700	0.2589	8.0133	700	0.258	8.0142
750	0.2588	8.0134	750	0.2575	8.0147	750	0.2565	8.0157
800	0.2578	8.0144	800	0.2561	8.0161	800	0.255	8.0172

Table 2. Table showing measured data from deformation test.					
Group 1		Group 2		Group 3	
Stress	Measured length	Stress	Measured length	Stress	Measured length
(psi)	(inches)	(psi)	(inches)	(psi)	(inches)
0	0.33215	0	0.33215	0	0.33215
150	0.3331	150	0.3333	150	0.33595
200	0.3334	210	0.3337	200	0.3365
250	0.3337	250	0.3339	250	0.337
300	0.3341	300	0.3351	300	0.3375
350	0.3346	350	0.3355	350	0.3379
400	0.3354	400	0.3359	400	0.33805
450	0.3358	450	0.33665	450	0.33855
500	0.3362	500	0.337	500	0.3388
550	0.3365	550	0.3371	550	0.339
600	0.3371	600	0.3378	600	0.33935
650	0.3374	650	0.3381	650	0.3397
700	0.3377	700	0.3384	700	0.33995
750	0.3379	750	0.3385	750	0.34035
800	0.3387	800	0.3387	800	0.3407

From the axial test raw data, we were able to formulate several plots of axial stress versus the deformation of the wall. There are plots of the three individual trials, and then there is a plot of the average data. These plots can be seen in Figure 1.

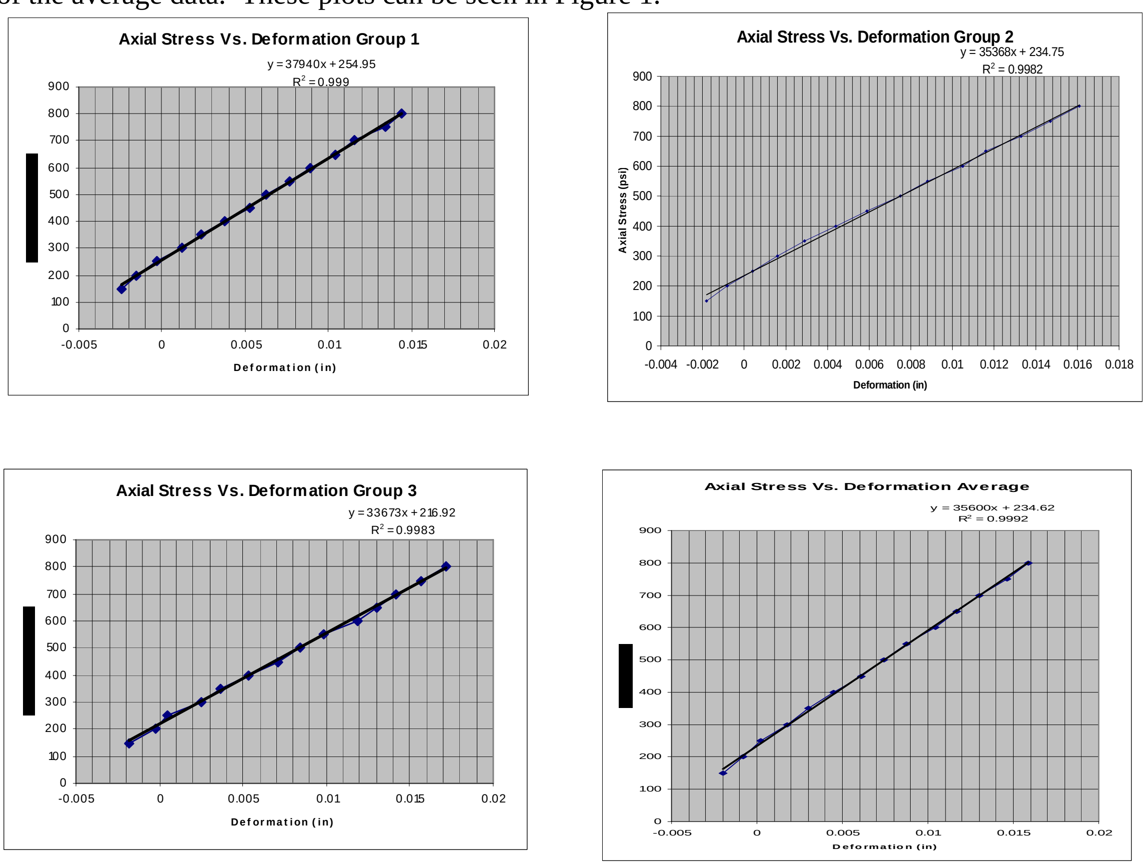

Figure 1. Axial stress versus deformation plots.

As you can see the correlation coefficient for the average is really close to 1. The average correlation coefficient should be more accurate than the individual group correlation coefficient due to the fact that our sample size is larger. The larger our sample size, the smaller our variance, thus the smaller the standard deviation. You can see that all of the groups were really close to the average correlation coefficient. In fact, all of the groups were approximately one thousandth off of the average. Group 1 had a correlation coefficient that was the closest to the average.

Using the data that was recorded for the axial stress test, we were able to determine that the stress in the wall to be 240 psi. When comparing this to the service load of 128 psi, which is composed of an 80 psi dead load and a 20 psi live load, our axial stress seems to be a bit off. This could be due to many factors. One possibility is that our gage for measuring the displacement could be slightly off. We have to remember that we are dealing with displacements of only two hundredths of an inch. When dealing with displacements this small, human error is very difficult to eliminate. Another possibility is the disks were not place exactly 8 inches apart. They could have been placed a couple hundredths off. Every one of these possible errors could easily contribute to the differences that are seen in the data.

One may ask, “What if we were to account for the cells in the masonry units?” This means that we would be dealing with a net area of only 60 percent of the gross area. The gross area was used in the determination of our axial stress. To answer the question one must take our determined axial stress of 240 psi, and divide it by 0.60. This gives us a result of 400 psi, which is further skewed from our calculated prediction. Besides, if this net area were more accurate than the gross area, we would have seen an imprint of the masonry sells in our flat jacks. Yet, we did not see any such imprints, which lead us to believe that our gross area is the more accurate of the two areas.

Using the data from our deformation test, Table 2 on the previous page, we were able to calculate the strain associated with the stress that was placed on the brick wall. We then could make plots of strain versus the applied axial stress to determine the slope, which is our modulus of elasticity. These plots can be seen in Figure 2.

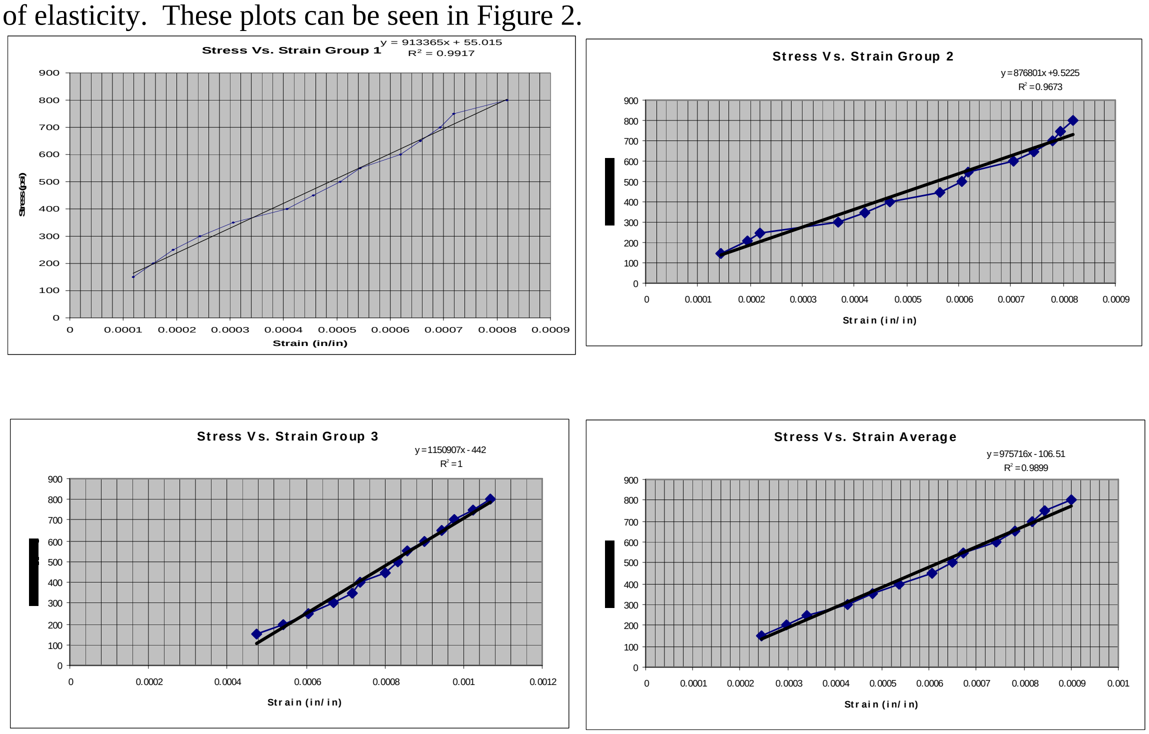

Figure 2. Stress versus strain graphs.

As you can see the correlation coefficient for the average is really close to 1. Again, the average correlation coefficient should be more accurate than the individual group correlation coefficient due to the fact that our sample size is larger. One can see that all of the groups were really close to the average correlation coefficient. In fact, all of the groups were within two one hundredths of the average. Group 3 had a correlation coefficient that was the closest to the average, and Group 1 had the largest correlation coefficient.

Upon inspection one can see that groups 1 and 2 were almost identical with their measurement, while group 3 was approximately two thousandths off. This is most likely due to a slight mis-calibration of the measuring device before the deformation testing procedure.

From the test data, the modulus of elasticity was found to be approximately 976 ksi, while the predicted modulus of elasticity from the MSJC manual was found to be 1050 ksi. Even though the experimental modulus of elasticity was a little lower than what was expected, it is still fairly accurate. Another point to remember is that the Anthropology Building is fairly old, and near the end of its life. Therefore, the wall may not be as stiff as specified by the MSJC.

The testing procedure for both the axial stress, and deformation went really well. The only problem that was encountered seemed to be the difference between the calculated axial stress, and the experimental axial stress. Without further analysis, and further funding, we will have to work with the data that was obtained from the axial stress test.

As a representative of my company, I would like to thank you for choosing us for the flat jack test. I feel that the experience was a success, since we were able determine the axial stress in the wall, and found a modulus of elasticity. If you have any comments or concerns feel free to contact me.

Thanks,

Zach Gutierrez