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Kentucky Transportation Center Research
Report

University of Kentucky

Year 1998

Survey and Visual Inspection of Keystone
Block Wall and Embankment Slide at
Mist Lake Plaza in Lexington, Kentucky

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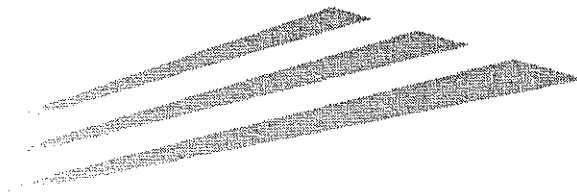
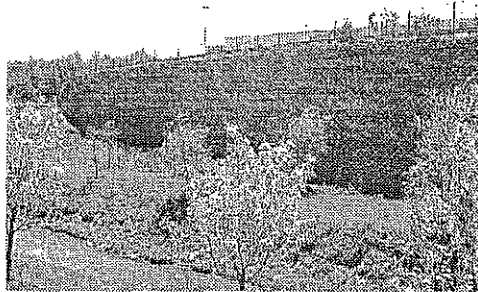
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KENTUCKY TRANSPORTATION CENTER

College of Engineering

SURVEY AND VISUAL INSPECTION OF KEYSTONE BLOCK WALL
AND EMBANKMENT SLIDE AT MIST LAKE PLAZA
IN LEXINGTON, KENTUCKY



UNIVERSITY OF KENTUCKY

Research Report KTC-98-6

**SURVEY AND VISUAL INSPECTION OF KEYSTONE BLOCK WALL
AND EMBANKMENT SLIDE AT
MIST LAKE PLAZA IN LEXINGTON, KENTUCKY**

by

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March 1998

INTRODUCTION

The Kentucky Transportation Center was requested by Bhate Engineering Corporation and A.B. Shopping Center Properties, Inc. to evaluate and monitor apparent movement in the Keystone Block retaining structure and the earth embankment located next to the Walmart Department Store at Mist Lake Plaza in Lexington, Kentucky. In June 1997, a report (KTC-97-11) was submitted which summarized work that had been conducted prior to June of 1997. The initial report included results of the inspection of the surface drainage, inspection of subsurface storm water drainage, inspection of the embankment, and inspection and photo-logging of visible wall distress. In June 1997, several monitoring points were established on the face of the wall and the parking area behind the wall. This report discusses the results of this monitoring.

SURVEY AND ESTABLISHMENT OF MONITORING POINTS

Wall Face

In June 1997, during the installation of monitoring points, it was brought to the attention of both Bhate and KTC that Black Engineering in Lexington had monitored the wall for Keystone Block Company during construction. Black Engineering was retained by KTC to resurvey the already existing monitoring points set for Keystone, and in addition, to establish additional points where needed. These monitoring points were last surveyed in September 1997. Survey information by Black Engineering is contained in Appendix A.

Vertical lines of monitoring points had been installed in five locations. The approximate locations are shown in Figures 1 and 2.

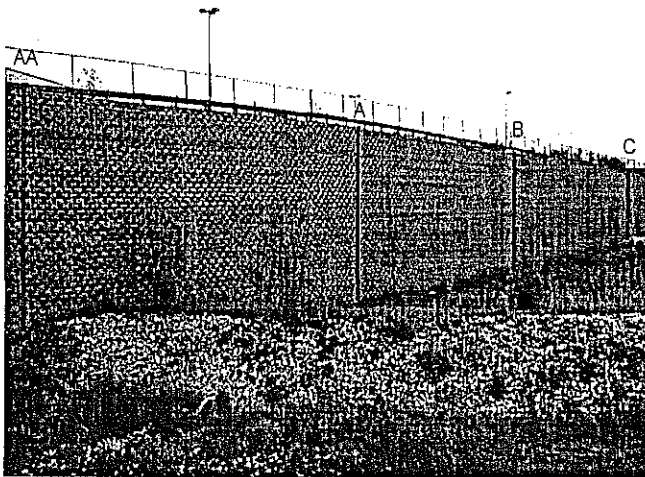


Figure 1

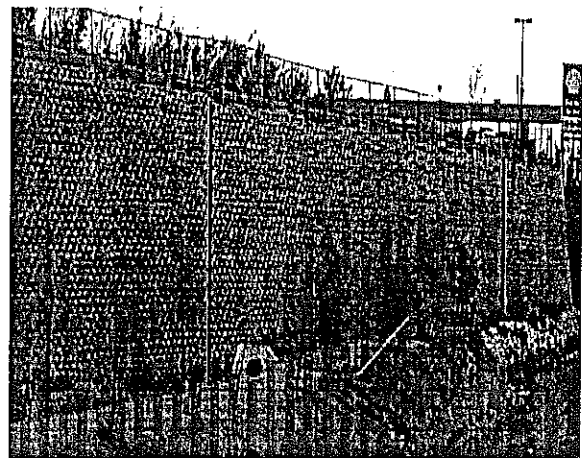


Figure 2

Readings taken by Black Engineering (Appendix A) indicate that the lower portion of the wall at Station A and Station B has moved forward 8 to 9 inches. It is apparent that a considerable amount of this movement had occurred during and shortly after construction. Approximately 1 to 2 inches of additional forward movement occurred between August 1994 and September 1997. To evaluate the rate of movement, data were analyzed back to May 22, 1993 when the wall was completed. The difference between readings has been plotted in Figures 3 through Figure 7. The Figures indicate that the rate of movement appears to have decreased significantly.

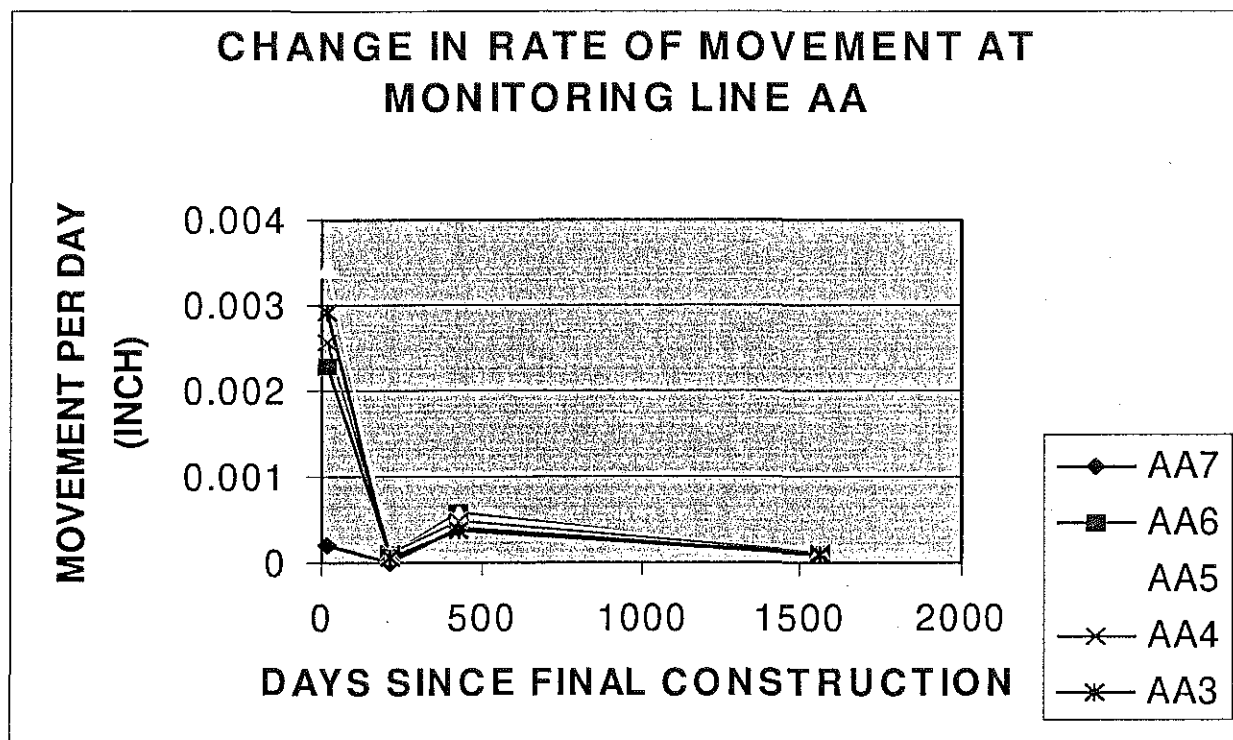


Figure 3. Monitoring Line AA

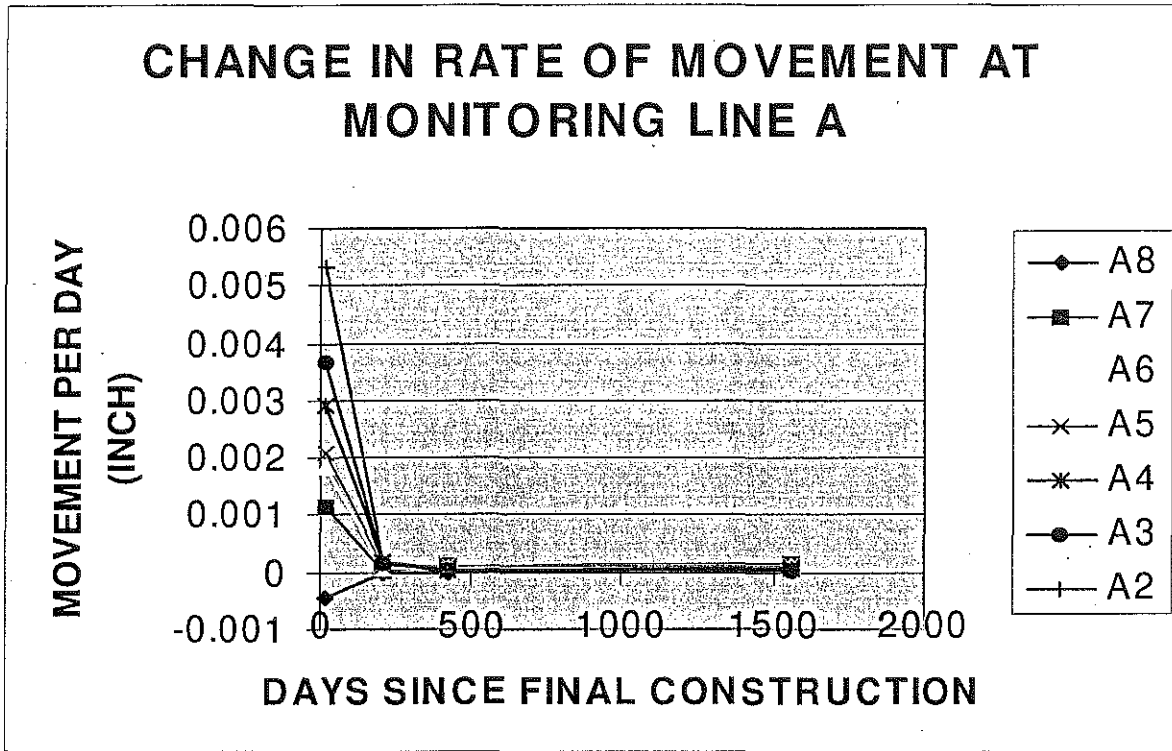


Figure 4. Monitoring Line A

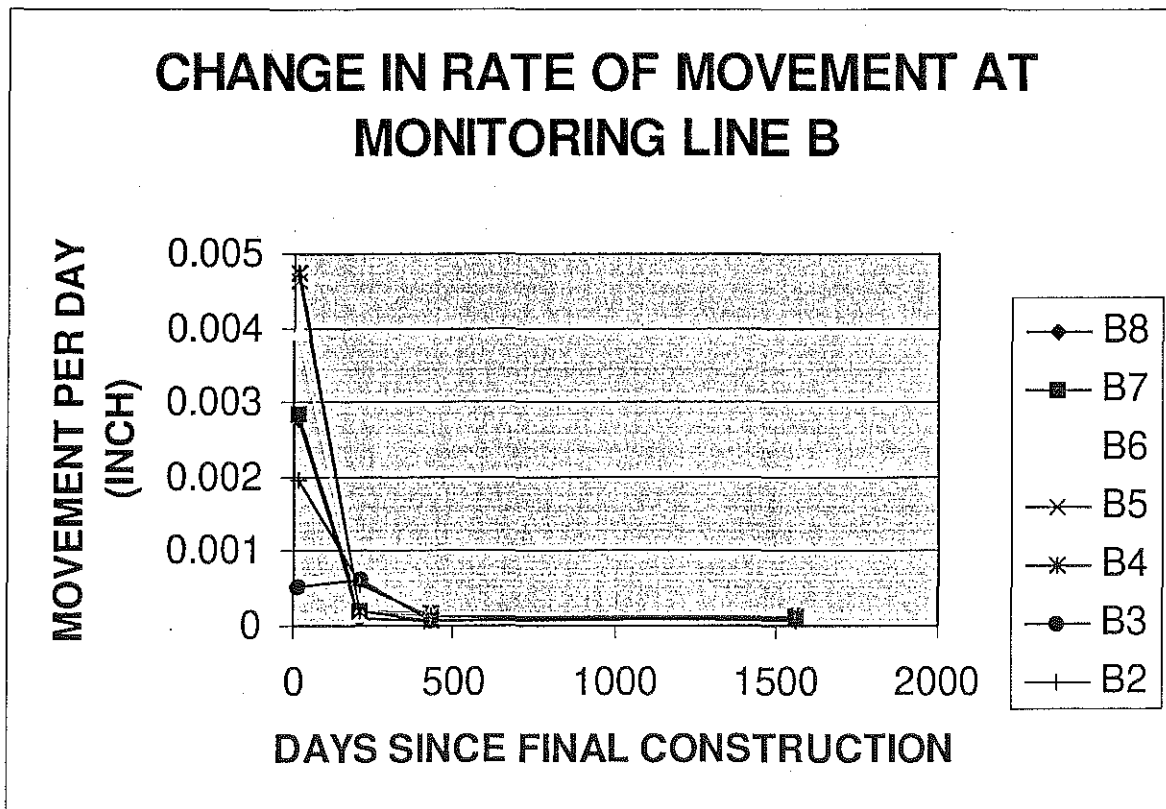


Figure 5. Monitoring Line B

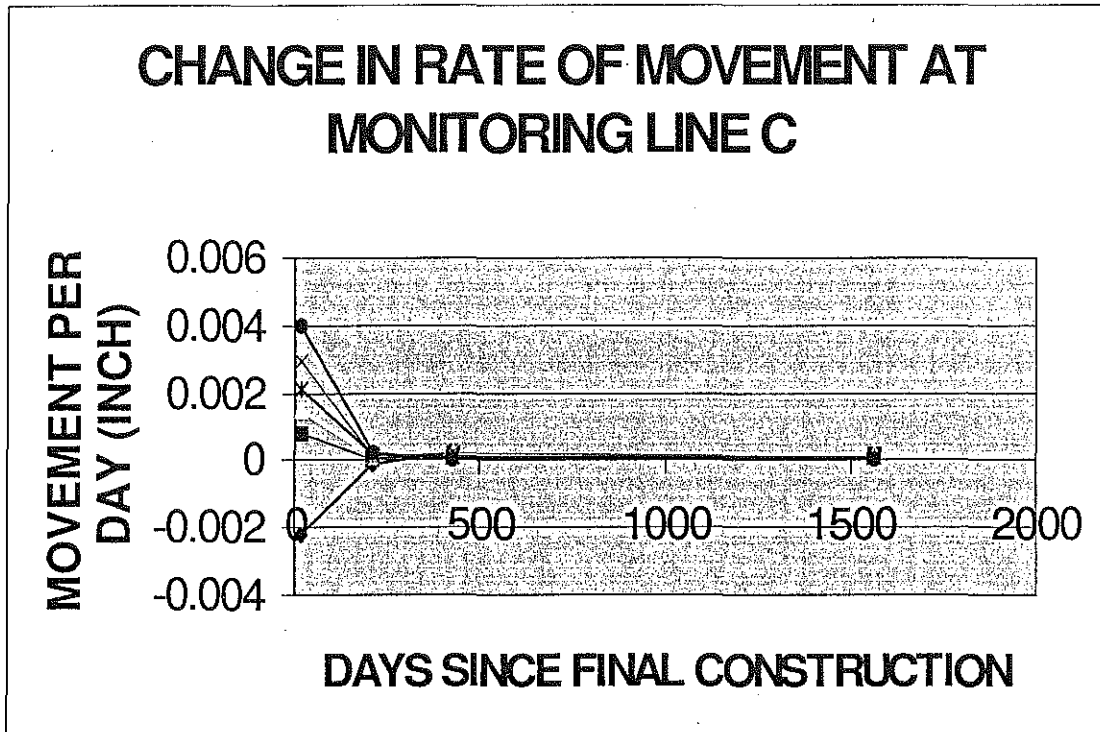


Figure 6. Monitoring Line C

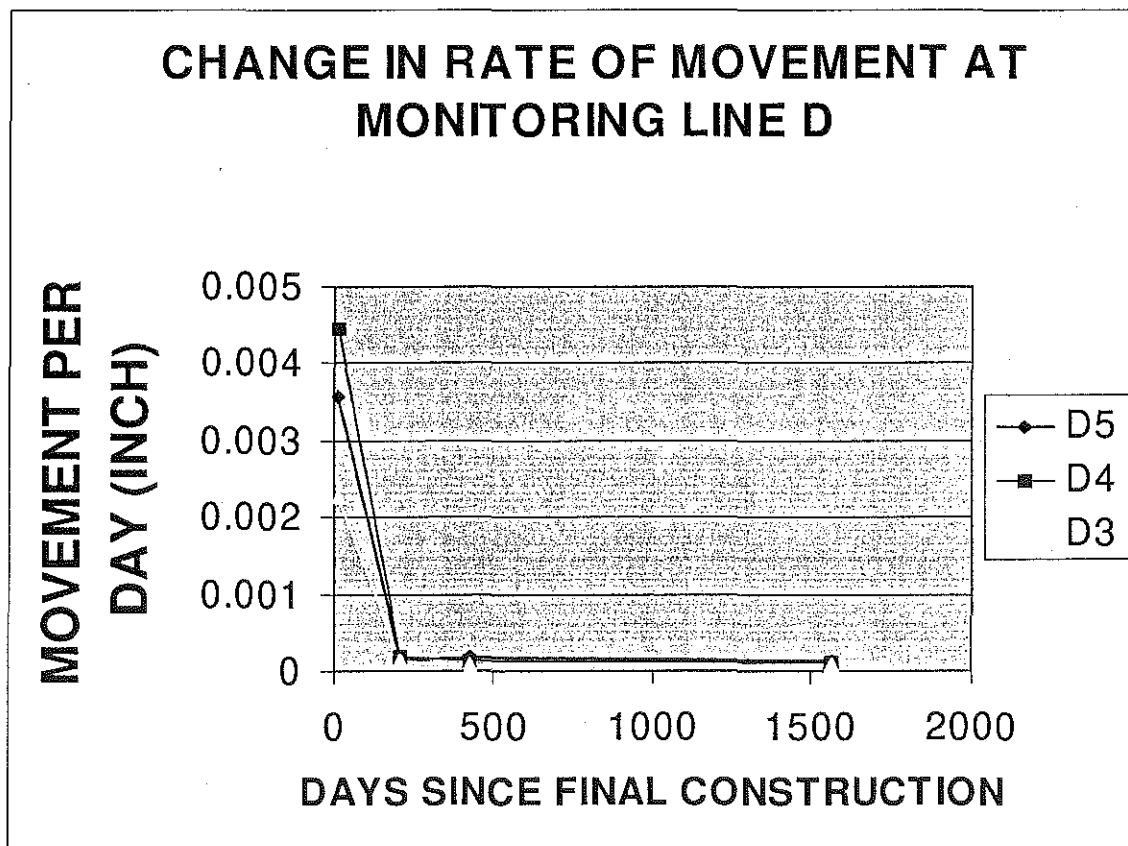


Figure 7. Monitoring Line D

From visual observations, it is apparent that forward displacement has occurred just north of monitoring line C, directly behind vertical catch basin No. SD4 (Storm Drain No. 4) (see location in Appendix B). Figures 8 and 9 show the displacement in the Keystone Wall around SD4. It is apparent that settlement in the fill around the catch basin has caused some forward displacement in the face of the wall structure. It was apparent, at the time of the last survey of the wall face, that monitoring line C was not close enough to record any of this movement. An additional monitoring line was installed at this location on September 24, 1997. Additional monitoring will provide better information on current rates of movement in the various wall segments.

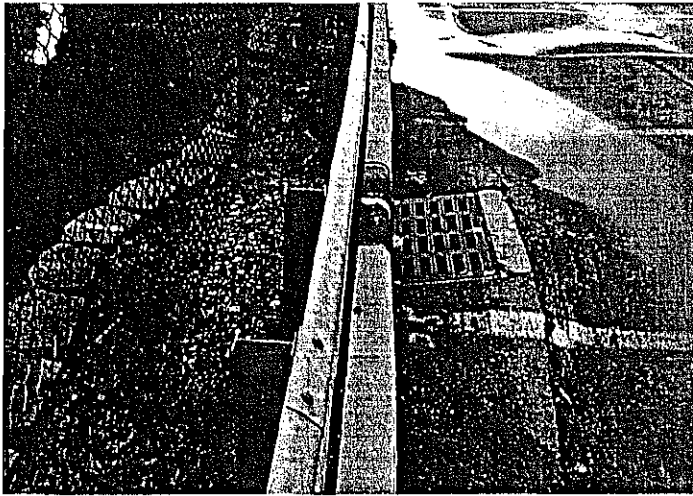


Figure 8. Showing change in wall alignment behind SD4.

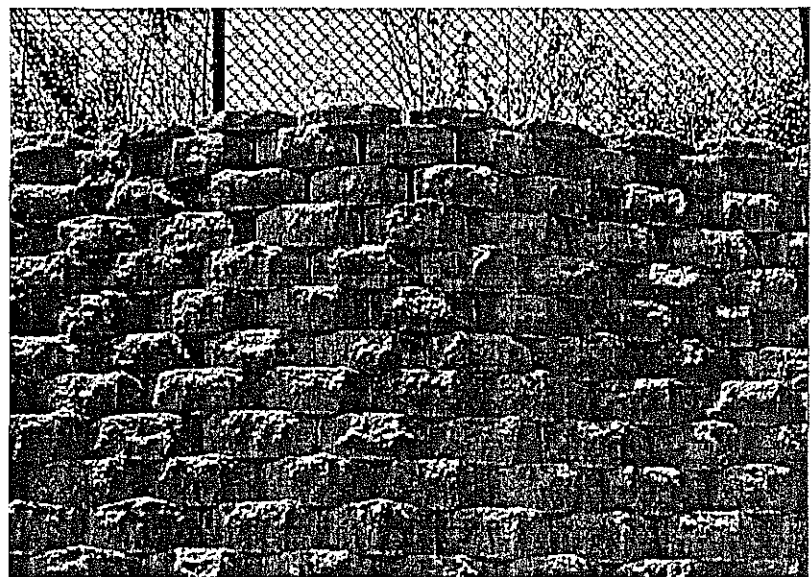


Figure 9. Forward Displacement in Keystone Wall occurring behind SD4.

Vertical Settlement

As mentioned in the initial report, vertical settlement of the asphalt pavement was apparent around the catch basins. A level survey of the parking area behind the retaining structure was conducted in 1997 (Figure 10). Settlement around SD3 (Figure 11) appears to be due to a significant amount of water infiltrating the risers in the drop box. In addition, material is also being lost on the backside of SD3 due to the earth embankment slide.

Water infiltrating into the riser of SD3 was sampled on July 1 and July 10, 1997. The water samples were taken to Kentucky American Water Company (KAWC) for testing. The fluoride levels tested were 0.3 and 0.4. KAWC concluded that the water was not treated water. KAWC indicated the source was likely ground water that has been running through limestone. KAWC indicated that limestone will increase the levels of fluoride by a couple of tenths.

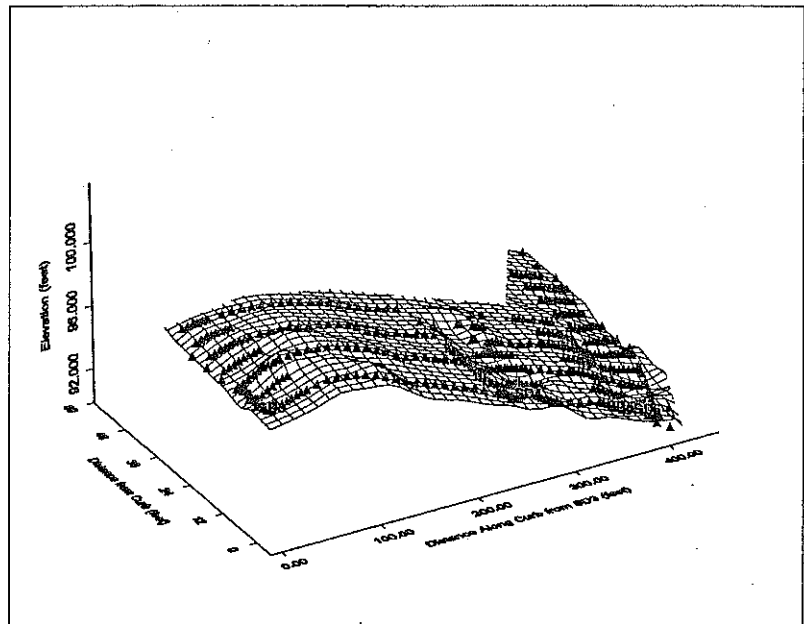


Figure 10. 3D Surface Plot of Parking Area Behind Keystone Block Wall.

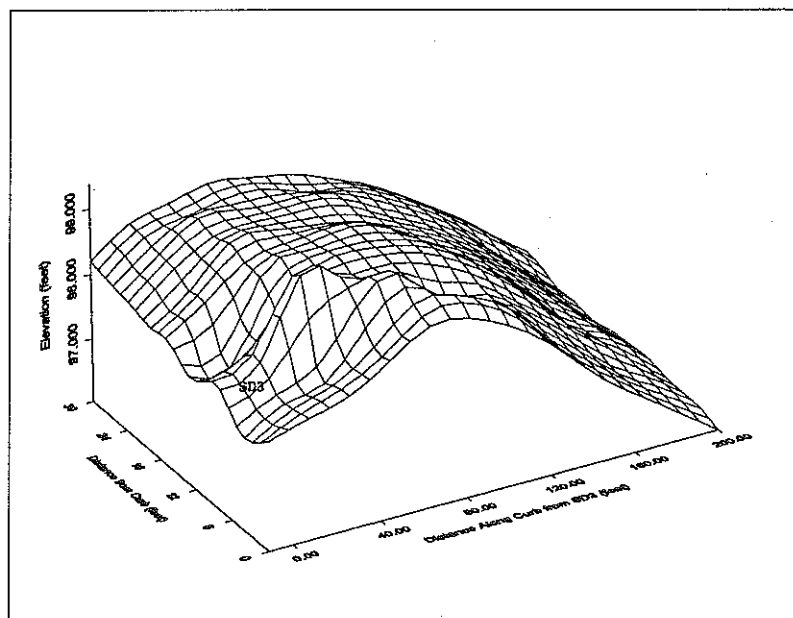


Figure 11. Settlement Observed Near SD3.

The most significant settlement is occurring around SD4. As shown in Figure 12, significant amounts of settlement have occurred directly in front of the catch basin. A large sunken area also extends back approximately 30 feet just left of the basin. This sunken area does not appear to follow any of the storm drains discharging into the basin. A portion of the material appears to be coming through the face of the wall.

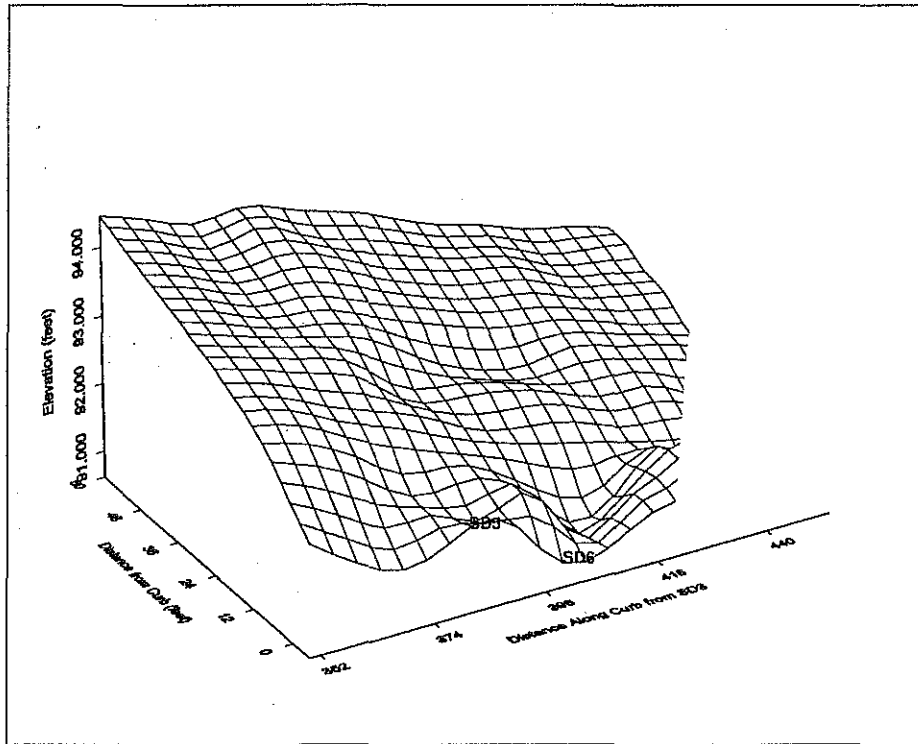


Figure 12. Settlement Observed Around SD5 and SD6.

A significant amount of settlement also appears to be occurring on the north end of the wall at SD5 and SD6. This is shown in Figure 13 and Figure 14.



Figure 13. Settlement Observed Around SD6.

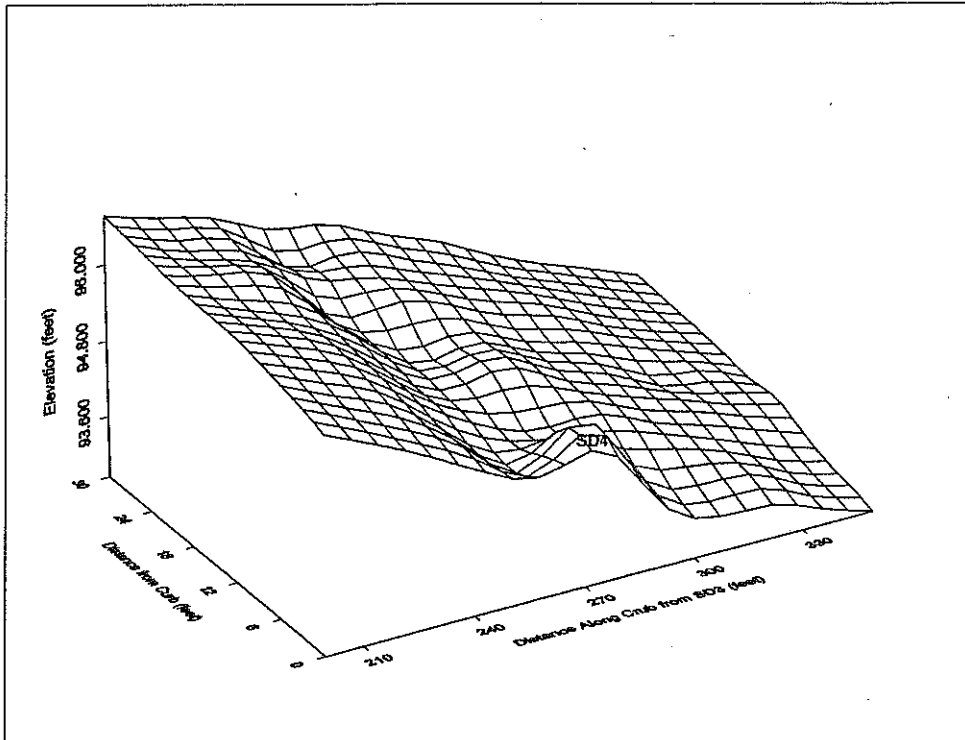


Figure 14. Observed Around SD4.

Visual Observations

Since the initial report, additional settlement has occurred around all the storm drains (catch basins). Separation of the concrete curb and the asphalt has increased near the earth embankment. Additional sliding of the embankment has occurred around the SD3 (Figure 15). The slide is starting to undermine the edge of the pavement (Figure 16).

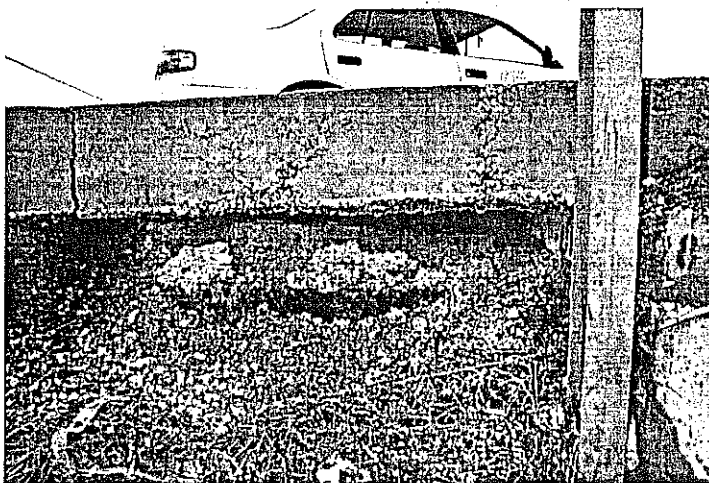


Figure 15. Edge of Pavement Undermined

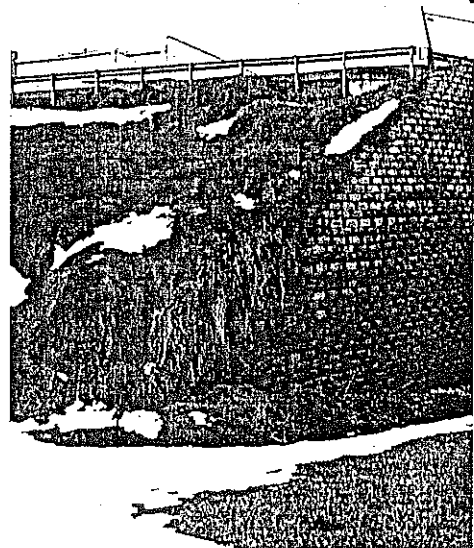


Figure 16. Embankment Slide

Staining on the base of the wall and erosion on top of the brim of the basin wall indicate that the water has flowed over the basin wall.

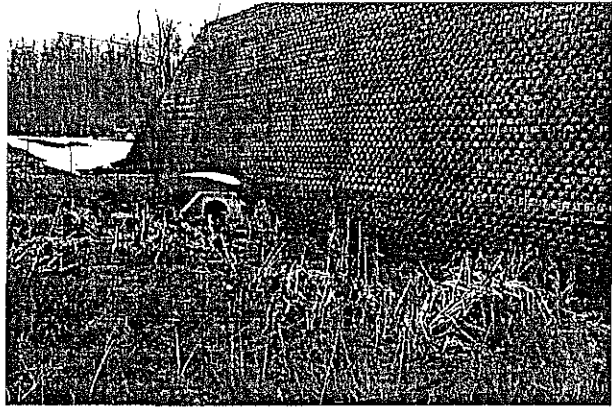


Figure 17. Retention Basis and Staining on the Keystone Wall, indicating High Water Levels.

CONCLUSIONS

It is apparent from the visual observations and the control surveys that since May of 1997 additional settlement has occurred in the parking area directly behind the wall. Most of the settlement is confined to the areas around the storm drains. Information from the control survey indicates that in several areas the base of the wall has moved eight to nine inches since construction. The rate of movement appears to have decreased significantly since final completion of the wall in 1993. At this time, without an additional survey, the current rate of movement cannot be determined. Additional monitoring points were established in areas that were not moving at the time the initial monitoring points were installed. Water samples collected and analyzed from SD3 indicated that the infiltrating water is ground water and not city water. Until the parking area is repaired and the water is channeled back to the storm drains, it is likely that movement in the wall and settlement in the parking area will continue.

RECOMMENDATIONS

It is recommend that an additional set of readings on both the face and the parking lot be should be obtained this Spring to determine the rate of subsidence in the parking area and forward movement in the retaining structure. A detailed survey of the face of the wall should also be conducted for future reference.

As recommend in the previous report:

The parking lot along the wall and the access road behind the store should also be repaved. Breaks in the concrete curb should be repaired. In addition, it is recommended that a french drain be installed to collect the water being discharged along the back of the store from the roof gutters. The embankment should be repaired as soon as possible to eliminate any further damage to the retaining structure and the parking lot. Some form of slope reinforcement is recommended for the slide rather than simply regrading and sodding. The surface water infiltrating the drop box inlets and the slide should be isolated. If this water is found to be flowing from the cut and fill, it is recommended that a cutoff trench be installed to intercept the water before it reaches the embankment and the retaining structure. Any cracks or separations in the pavement and curb should be sealed prior to placement of the overlay.

APPENDIX A
SURVEY BY BLACK ENGINEERING


PRECISION SURVEY
KEYSTONE RETAINING WALL
MIST LAKE PLAZA
LEXINGTON, KENTUCKY

(Revised 09-24-1997)

Vertical Line in Wall Face	Horiz. Dist. from Baseline, ft.	Horiz. Dist. from Baseline, ft.	Horiz. Movement from Initial Reading, in.	Horiz. Dist. from Baseline, ft.	Horiz. Movement from Initial Reading, in.	Horiz. Dist. from Baseline, ft.	Horiz. Movement from Initial Reading, in.	Horiz. Dist. from Baseline, ft.	Horiz. Movement from Initial Reading, in.	Horiz. Dist. from Baseline, ft.	Horiz. Movement from Initial Reading, in.	Horiz. Dist. from Baseline, ft.	Horiz. Movement from Initial Reading, in.	Horiz. Dist. from Baseline, ft.	Horiz. Movement from Initial Reading, in.	Horiz. Movement 5/22/93 to 09-24-97 in.
	05-02-93	05-06-93		05-09-93		05-22-93		06-08-93		12-23-93		08-01-94		09-24-97		Post-Construction
AA TOP (elev)				107.91		110.98										
AA7						234.3989		234.3955	0.0408	234.3941	0.0576	234.3060	1.1148	234.2020	2.3628	2.3628
AA6						233.7145		233.6779	0.4392	233.6634	0.6132	233.5400	2.0940	233.4270	3.4500	3.4500
AA5						233.0486		232.9936	0.6600	232.9766	0.8640	232.8570	2.2992	232.7310	3.8112	3.8112
AA4				232.5835		232.3825	2.4120	232.3412	2.9076	232.3182	3.1836	232.2107	4.4736	232.0920	5.8980	3.4860
AA3				231.9682		231.7780	2.2824	231.7312	2.8440	231.7179	3.0036	231.6389	3.9516	231.5320	5.2344	2.9520
AA2				231.3163		231.1389	2.1288							230.9050	4.9356	2.8068
AA1				230.9828		230.8047	2.1372									
AA BOT (elev)				83.22												
A TOP	96.10	103.40		110.70		116.85										
A9						235.4068								235.3350	0.8616	0.8616
A8						234.6386		234.6458	-0.0864	234.6500	-0.1368	234.6493	-0.1284	234.4890	1.7952	1.7952
A7						233.8921		233.8742	0.2148	233.8659	0.3144	233.8452	0.5628	233.6930	2.3892	2.3892
A6						233.2050		233.1755	0.3540	233.1607	0.5316	233.1451	0.7188	233.0030	2.4240	2.4240
A5						232.6702		232.6369	0.3996	232.6145	0.6684	232.5879	0.9876	232.4760	2.3304	2.3304
A4		232.5614		232.3650	2.3568	232.0832	5.7384	232.0366	6.2976	232.0032	6.6984	231.9930	6.8208	231.9220	7.6728	1.9344
A3	232.0590	231.9943	0.7764	231.8446	2.5728	231.5254	6.4032	231.4670	7.1040	231.4373	7.4604	231.4317	7.5276	231.3810	8.1360	1.7328
A2	231.4164	231.3975	0.2268	231.2514	1.9800	230.9851	5.1756	230.8997	6.2004	230.8617	6.6564	230.8628	6.6432	230.7790	7.6488	2.4732
A1	231.0298	231.0221	0.0924	230.9821	0.5724	230.8394	2.2848	230.7562	3.2832							
A BOT	83.41															
B TOP	96.12	103.50		110.27		115.39										
B8						234.8186		234.7742	0.5328	234.7559	0.7524	234.7400	0.9432	234.5870	2.7792	2.7792
B7						234.0749		234.0296	0.5436	233.9924	0.9900	233.9600	1.3788	233.8020	3.2748	3.2748
B6						233.2487		233.1856	0.7572	233.1533	1.1448	233.1178	1.5708	232.9650	3.4044	3.4044
B5						232.4237		232.3492	0.8940	232.3134	1.3236	232.2849	1.6656	232.1520	3.2604	3.2604
B4						231.7657		231.6901	0.9072	231.6544	1.3356	231.6384	1.5276	231.5220	2.9244	2.9244
B3	231.8779	231.7980	0.9588	231.6429	2.8200	231.3396	6.4596	231.3311	6.5616	231.2084	8.0340	231.1935	8.2128	231.0980	9.3588	2.8992
B2	231.3571	231.3176	0.4740	231.1717	2.2248	230.8874	5.6364	230.8559	6.0144	230.7468	7.3236	230.7204	7.6404	230.6370	8.6412	3.0048
B1	230.9842	230.9704	0.1656	230.9129	0.8556	230.7666	2.6112									
B BOT	84.08															
C TOP	89.54	89.54		97.77		109.78										
C7						234.3534		234.3880	-0.4152	234.4059	-0.6300	234.3487	0.0564	234.1690	2.2128	2.2128
C6						233.5922		233.5800	0.1464	233.5756	0.1992	233.5199	0.8676	233.3360	3.0744	3.0744
C5						232.7025		232.6789	0.2832	232.6608	0.5004	232.6160	1.0380	232.4350	3.2100	3.2100
C4		232.4893		232.4805	0.1056	232.2750	2.5716	232.2279	3.1368	232.2030	3.4356	232.1588	3.9660	232.0170	5.6676	3.0960
C3	231.9437	231.9333	0.1248	231.9208	0.2748	231.7015	2.6316	231.6680	3.3084	231.6407	3.6360	231.6223	3.8568	231.5190	5.0964	2.1900

C2	231.4166	231.3967	0.2388	231.4009	0.1884	231.2466	1.8516	231.1831	2.8020	231.1426	3.2880	231.1351	3.3780	231.0840	3.9912	1.9512
C1																
C BOT	84.21															
D TOP				93.09		103.61										
D5						233.1866		233.1295	0.6852	233.1029	1.0044	233.0648	1.4616	232.9210	3.1872	3.1872
D4						232.6406		232.5693	0.8556	232.5319	1.3044	232.5041	1.6380	232.3780	3.1512	3.1512
D3				232.0378		231.9643	0.8820	231.9281	1.3164	231.9031	1.6164	231.8853	1.8300	231.7840	3.0456	2.1636
D2				231.1525		231.0830	0.8340	231.0449	1.2912							
D1				230.5444												
D BOT				86.17												

← Construction complete

 Blocks installed but no readings taken due to inaccessibility to top of wall during construction.

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J. E. BLACK

Lexington, Kentucky

APPENDIX B
LOCATION OF STORM DRAIN INLETS

