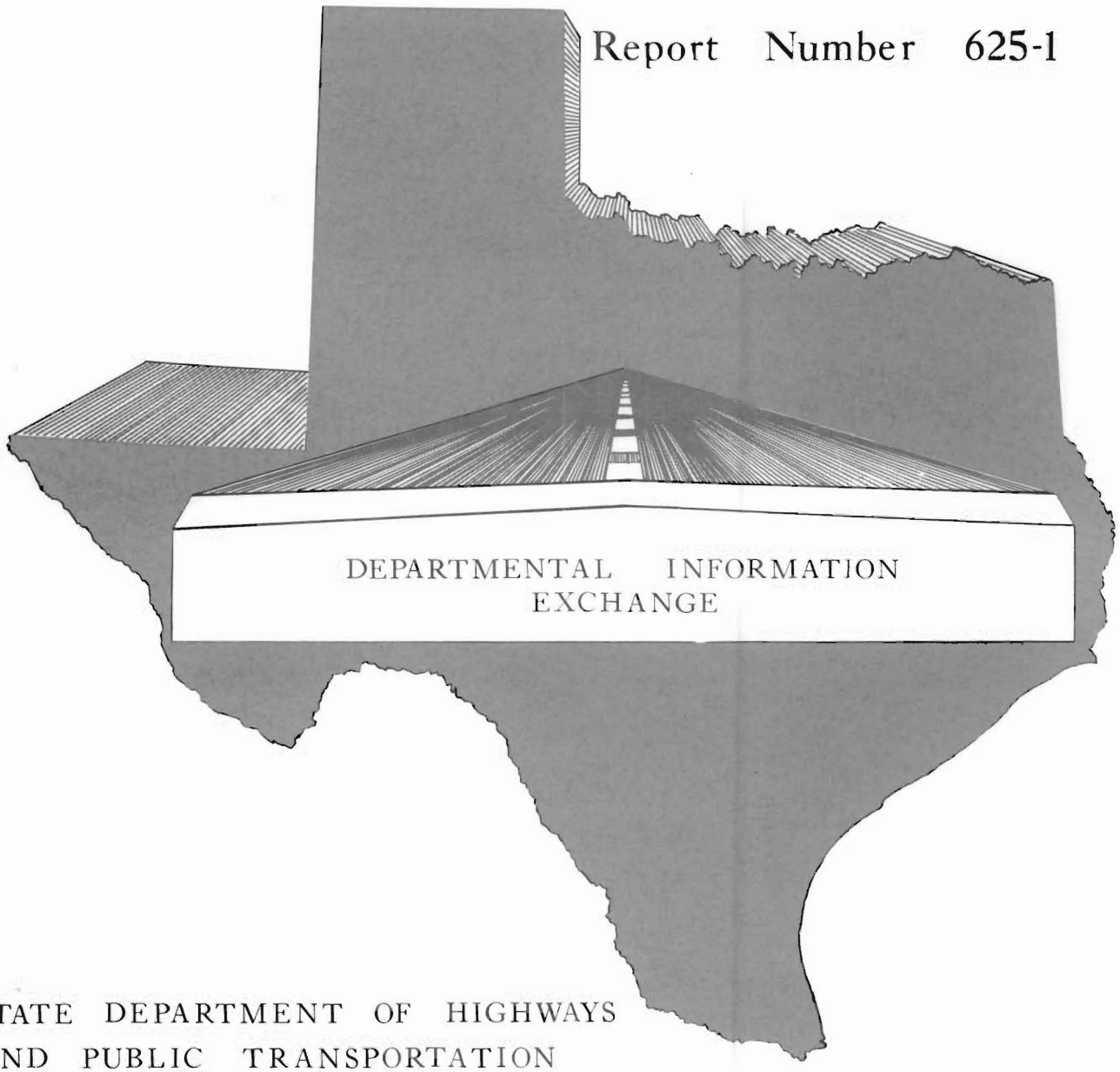
EXPERIMENTAL PROJECTS

EVALUATION OF PRESSURE GROUTING EXISTING CONCRETE PAVEMENT

Report Number 625-1



STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

EVALUATION OF
PRESSURE GROUTING
EXISTING CONCRETE PAVEMENT

IH-10

FROM 3.0 MILES WEST OF GLIDDEN

TO ALLEYTON ROAD

BY:

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STATE DEPARTMENT OF HIGHWAYS

& PUBLIC TRANSPORTATING

District 13

EXPERIMENTAL PROJECT

Report 625-1

December, 1979

DISCLAIMER STATEMENT

The material contained in this report is experimental in nature and is published for informational purposes only. Any discrepancies with official views or policies of the DHT should be discussed with the appropriate Austin Division prior to implementation of the procedures or results.

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INTRODUCTION:

This report is dealing with the contract between the State Department of Highways and Public Transportation and Dean Word Company let November, 1978. The project work consisted of repair and pressure grout existing concrete pavement, asphaltic concrete pavement overlay and upgrade existing metal beam guard fence. This report will focus on the pressure grouting of the existing concrete pavement as set up in the Specifications that are to be discussed.

This project, I-IR 10-6(30)690, was located in District 13 on Interstate Highway 10 from 3.0 Miles West of Glidden to 0.6 Mile East of Alleyton Road for a total of 8.932 miles. Dean Word Company requested and received approval of Del Val, Inc., of Portland, Oregon, as a Subcontractor to do the pressure grouting work at an estimated cost of $178,467.

DESCRIPTION:

The pressure grouting was set up under Special Specification Item 3117, Pressure Grouting Concrete Pavement. This Item consisted of stabilizing Portland Cement Concrete Pavement by pumping under the continuously reinforced concrete slab, grout of a specified mixture of Portland Cement, a fluidifier, fine sand and water. The purpose of this operation was to fill voids beneath the slabs with a mixture that will form a hard insoluble mass.

MATERIALS:

The materials specified for use consisted of Type I Portland Cement, a fluidifier, fine sand and water proportion as specified, or as directed by the Resident Engineer. All materials to be furnished by the Contractor. To assure proper proportions on this project, the sand and cement were distributed to the mix by sacked components.

PROPORTIONING GROUT MIXTURE:

The mixture to be used was to consist of proportions of Portland Cement (by dry volume), fine sand (by dry volume), fluidifier (by weight) and water.

The sand-cement ratio (by dry volume) was to be between 1:2 and 3:1 unless otherwise directed by the Resident Engineer. The quantity of fluidifier was to be included in the mixture from 0.5% to 1.5% by weight of cement.

The quantity of mixing water to be used was to produce a grout of a consistency such that the time of efflux from a flow cone will be a minimum of twenty seconds and a maximum of twenty five seconds. The flow cone and flow test was the same as set out in the "Method of Test for Flow of Grout Mixtures".

PAYMENT:

The payment for this work was for holes drilled and bags of Portland Cement incorporated into the mix. The contract price of the Portland Cement included the furnishing of the fluidifier, fine sand, water and all incidentals and manipulations required.

Under this contract the bid price for completed holes was $2.60 each. The bid price for bags of Portland Cement was $24.50 per 94 lb. bag.

PURPOSE:

With the excessive amount of cracking and punchouts in the Continuous Reinforced Concrete Pavement and previous tests and studies made, it was determined that there should be voids under the concrete pavement located between the concrete pavement and the cement treated material. (See Sheet No. 7). Upon excavation along the edge of the pavement, between it and the shoulder, the material excavated the full 8" pavement depth was found to contain little to no binder or fines. Only segregated, loose gravel was found. This evidenced pumping of water out from under the pavement. The shoulders showed signs of "streaking", this being water and light fines being flushed from under the pavement and out through the cracks between the pavement and

shoulder. Maintenance had performed similar work previously on a section of I-10 just East of this project for the purpose of filling the voids under the pavement. The pavement in that section had the same failures and bad conditions as of that under this project. The previous grouting project was successful in pumping sand-cement grout under the pavement and the experience gotten from this previous project was used to write the Specifications to be used on the project included in this report.

For reference to the construction roadbed and pavement see Sheet No. 7.

As initially set up, the areas to be pressure grouted were determined by an experienced visual examination of the pavement and determining whether these selected sections should receive a partial or a full hole pattern as set up as Hole Pattern No. 1 (See Sheet No. 8).

D-10 Research became interested in our project and asked to Dynaflect the entire length of our project for an examination of possible voids by use of the Dynaflect. Using the readings made by the D-10 Research, this office felt that a better evaluation could be made of which areas should be pressure grouted and which could receive only partial or even no treatment. The Dynaflect readings and previous evaluations were compatible as to defined areas to be treated.

CONSTRUCTION:

At the beginning of construction, the mix used was a sand and cement ratio of 1:2 using an approved fluidifier called Orzan A. The hole pattern used was as set up in the plans and shown as Hole Pattern No. 1 on enclosed Sheet No. 8. The depth of the initial drilling was 8" which is just the depth of the concrete pavement as shown on the section on Sheet No. 7.

Several areas (different locations) were drilled and the pumping of grout was attempted with little to no grout being placed under the slab (reference attached Sheet No. 9). Several variations with respect to mixtures were tried to thin the mix including a pure cement mix with no sand, a flyash and cement mixture and

finally just water, all under a 400 psi pressure. Nothing was pumped under the pavement. The tests were done in the most deteriorated section of pavement with no results. We also experimented with several sand-cement ratios by changing the water ratio but could only get an approximate 12 second flow using the Flow Cone Test Method.

Upon evaluating the procedures we were using with no success, it was decided to experiment for other results. We authorized the drilling of the holes to a depth of 18" using Hole Pattern No. 2 to check if a grout flow could be established (See Sheet No. 8).

The Contractor was able to pump grout at a rate of approximately one cubic foot per hole pumped. There seemed to be no resistance to flow into these holes, however, the Flow Cone Test yielded only a 13 second flow. With no resistance to flow, it was decided to change the sand-cement ratio to 3:4. The results were satisfactory but with no change in flow, however, more volume for the amount of cement was produced. To assure uniform coverage of the areas requiring grouting, we changed the hole pattern to Pattern No. 3 as shown on Sheet No. 7. With this pattern the flow of grout could be seen from hole to hole. At this point we also changed to a 14" hole. This depth was determined to be the needed depth by experimenting with a hole depth pattern. This was accomplished by drilling consecutive holes in one inch increments from 8" to 18" depths. In almost all cases the grout began pumping at the 14" depth hole. All holes of less than 14" depth did not take grout.

When using the sand-cement grout, the Contractor was required to keep traffic off the grouted area for three hours after the pumping operation was completed to allow proper setting time.

With this hole pattern, hole depth and sand-cement ratio, the procedure appeared to be tested and proved as a workable procedure. We continued without little if any variance for approximately 3500 holes with an average pumping rate of 1.75 cf/hole. The rate of construction averaged at about 150 holes pumped each day.

up to this point in construction, the pumping of the grout had been done only in East Bound Lanes of I-10. It was decided and field changed at this point to change the grout compenents to make it possible for the Contractor to use a Flyash-cement grount, Comparison testing was to be performed to determine effectiveness of each mix. A reduction of price was offered with the use of the fly-ash grout mixture.

FLYASH-CEMENT MIXTURE

MATERIALS:

The materials consisted of a mixture of Type I Portland Cement, a fluidifier, pozzolan (flyash) and water proportion as specified or as directed by the Resident Engineer. The pozzolan used on this project was from approved sources, these being the Parrish and Deely Plants, and this pozzolan was added to the mix as sack components.

PROPORTIONING GROUT MIXTURES:

The proportioning included 1 part (by volume) Portland Cement Type I or II, 3 parts (by volume) Pozzolan (Natural or Artificial), with an approved water content that would allow a flow of such consistency that the time of efflux from the flow cone will be a minimum of ten seconds and a maximum of twenty five seconds. An approved expanding agent was powdered unpolished Aluminum at a rate of two grams per cubic foot of mixture. The approved fluidifier was again the Orzan A at a rate of one fourth of a pound per cubic foot of mixture.

PAYMENT:

The payment for the work was for holes drilled and for the cubic foot of Portland cement and Pozzolan incorporated into the mix. The contract price for holes remained at $2.60 each. The price for the Portland Cement was lowered to $16.60 per cubic foot but the addition of $15.35 for a cubic foot of Pozzolan was added to the total cost of the mix. All other materials and manipulations were to be included in the bid prices.

CONSTRUCTION:

Using the flyash-cement grout the remainder of the project in the West Bound Lane was completed. The blunt of the grouting work being done in the areas of pavement that showed signs of swells and upheavals. The ratio of flyash to cement remained at 3:1 and the hole depth and pattern were kept at 14" and hole pattern No. 3 respectively. The flyash-cement grout was pumped into approximately 4100 holes at an average rate of two cubic feet per hole. The average number of holes pumped per day was just over 175 holes. The flyash-cement mixture had an average Flow Cone time of efflux of 11 to 12 seconds.

CONCLUSION:

There is no exact science to this construction procedure to accurately gage the level of success on this project. The grout did not pump under the pavement as planned. The grout under the base of the approximate 14" depth did flow at a rate that showed little resistance to flow once the flow began. The Benkelman Beam was used on the project to reflect the movement difference between the shoulder and the pavement. No significant if any movement was found to occur. It is questioned whether the pumping was not making its own void and forcing itself between construction material layers and not just filling voids. To illustrate the possibility that the grout formed an opening of its own, we started with an area that was pumping freely from hole to hole. Then we skipped approximately 8 holes or about 30' of pavement and tried to grout again with no success. The holes would not pump. Upon going back to where we initially were pumping and pumped through the skip to the holes that would not pump and those holes proceded to pump and the following holes also pumped. If holes would not pump in areas, water could be poured into the holes prior to again trying to pump and they would then pump. This was noticed initially after a shower of rain that an area prior to rain would not pump and after the rain did pump.

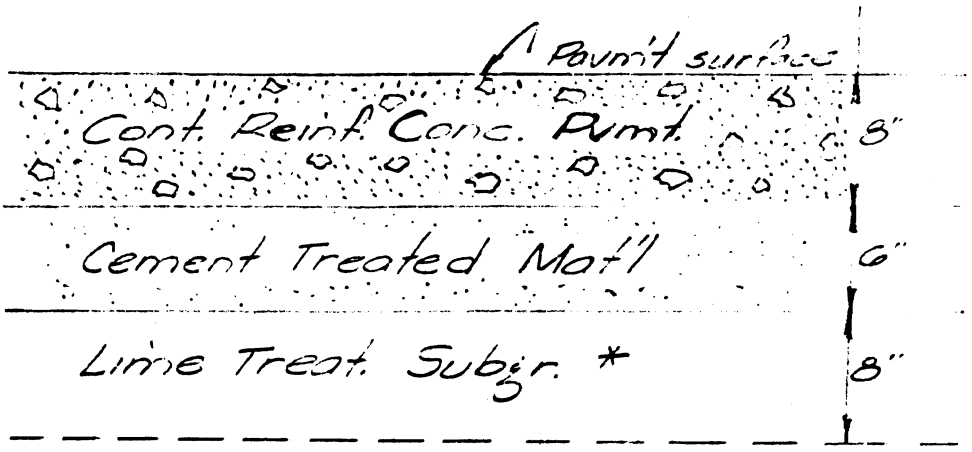
Dr. Frank McCoulough and his research team evaluated the pressure grouted areas by Dynaflect prior to grouting, immediately following grouting and two to four weeks after grouting and found the Dynaflect readings immediately following grouting to be worse than original readings showing a possible detriment to the area instead of a rehabilitation. The Dynaflect readings made three weeks or so after grouting showed about the same readings as made prior to grouting. This indicates no improvement in the pavement with respect to the Dynaflect readings. The final results of the Dynaflect readings are forthcoming upon completion by D-10 Research and University of Texas Center for Highway Research.

We had the pavement that had been grouted core drilled to check where the grout was appearing under the pavement surface.

The use of flyash-cement grout showed a better flowing and finer mix that would flow into smaller voids than that of sand-cement grout. The flyash-cement grout had a quicker set up time than its counter grout but this has its advantages and disadvantages. The advantage being that you can put traffic on the grouted pavement sooner, however, with this mixture setting up sooner than sand-cement grout, a pavement area that does not accept grout would require the grout to be disposed of before it sets up in the pumps and equipment.

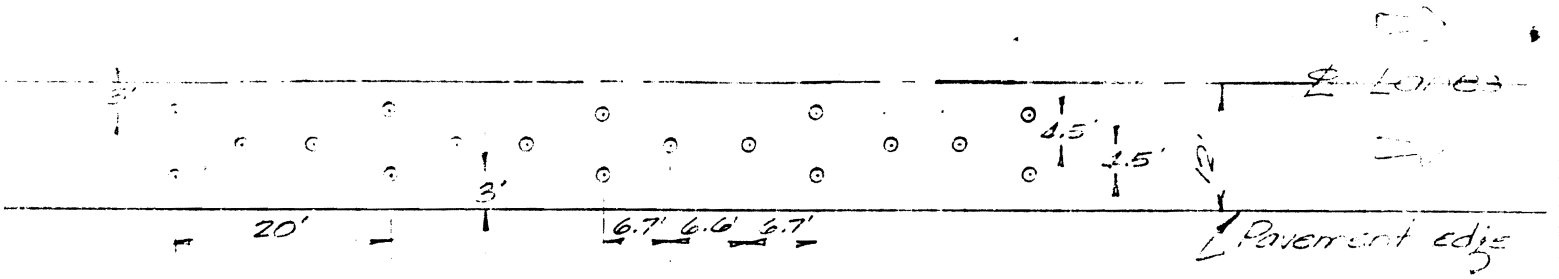
The overall results and outcome of this grouting will only be determined after future testing which will allow us to evaluate the results over a period of years.

TYPICAL RDWY SECTION

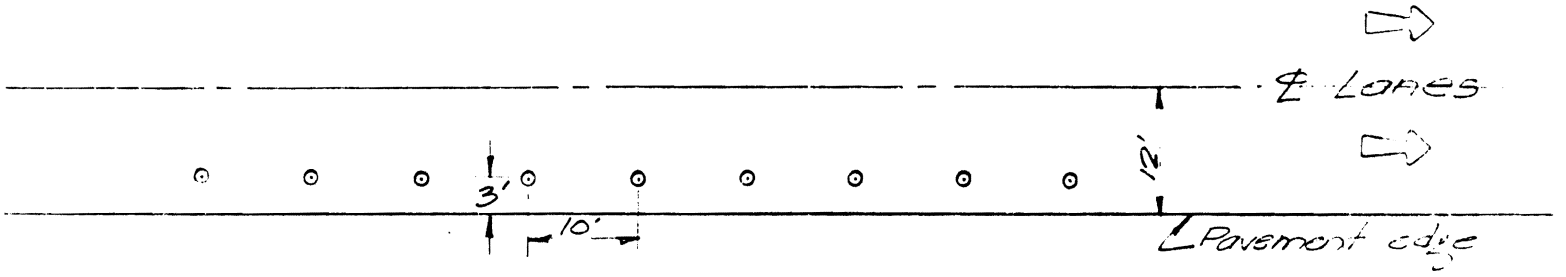


* Lime Treated Subgrade from sta 79 to sta 132 only.

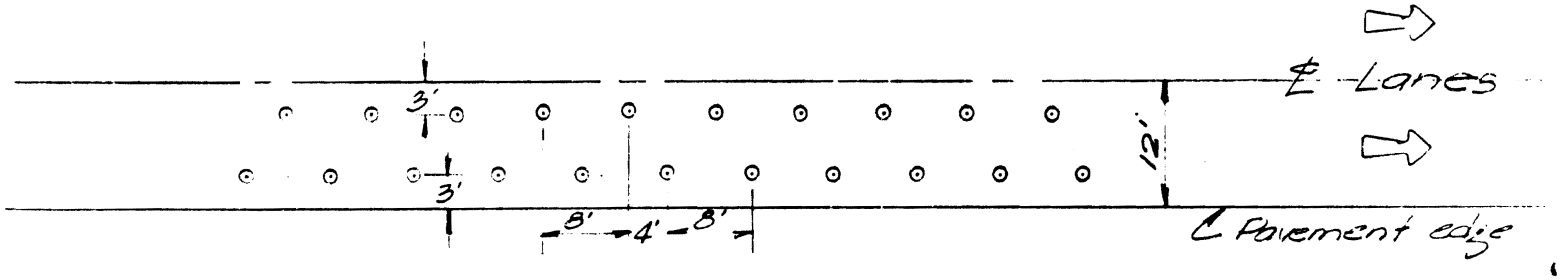
HOLE PATTERNS



Pattern No. 1



Pattern No. 2



Pattern No. 3

PRESSURE GROUT (Sand-Cement)

Date	Location	Lane	Holes Pumped	Holes Did Not Pump	Ratio	Cement Used Bags	Sand Used Bags	Total Bags /Day	C.F. /Hole Pumped	Approx. Hole Depth
3-26-79	748+00-755+60	E.B.(Outside)	2	119	1:2	12	6	18	9.00	8"
3-27-79	755+60-761+72	E.B.(Outside)	-	72	1:2	3	non	pumped		8"
3-28-79	89+73- 91+66	E.B.(Outside)	1	36	1:2	6	3	9	9.00	8"
4-05-79	91+66-101+30	E.B.(Outside)	98	-	1:2	64	32	96	0.98	18"
4-09-79	101+30-107+52	E.B.(Outside)	63	50	3:4	58	37	95	1.51	18"
4-10-79	107+52-113+73	E.B.(Outside)	92	52	3:4	68	51	119	1.29	18"
4-12-79	113+73-124+54	E.B.(Outside)	78	104	3:4	52	39	91	1.17	14"
4-16-79	124+54-134+58	E.B.(Outside)	140	110	3:4	48	36	84	0.60	
4-17-79	134+50-135+50	E.B.(Outside)			1:2	28	14	42		14"
4-17-79	135+50-140+00	E.B.(Outside)	136	-	3:4	92	69	161	1.49	14"
4-18-79	140+00-149+50	E.B.(Outside)			3:4	48	66	114		14"
4-18-79	140+00-149+50	E.B.(Outside)	72	148	1:2	20	10	30	2.00	14"
4-19-79	774+00-775+75	E.B.(Outside)	35	10	3:4	24	18	42	1.20	14"
4-20-79	775+75-779+94	E.B.(Outside)	103	2	3:4	92	69	161	1.56	14"
4-23-79	779+94-784+68	E.B.(Outside)	87	32	3:4	88	66	154	1.77	14"
4-24-79	784+68-791+76	E.B.(Outside)	92	85	3:4	116	87	203	2.21	14"
4-25-79	791+76-799+04	E.B.(Outside)	155	28	3:4	120	90	210	1.35	14"
4-26-79	799+04-805+30	E.B.(Outside)	133	23	3:4	128	96	224	1.68	14"
4-27-79	805+30-810+54	E.B.(Outside)	102	30	3:4	120	90	210	2.06	14"
4-30-79	810+54-817+26	E.B.(Outside)	141	28	3:4	148	111	259	1.84	14"
5-01-79	817+26-823+30	E.B.(Outside)	148	1	3:4	160	120	280	1.89	14"
5-02-79	823+30-832+34	E.B.(Outside)	203	23	3:4	200	150	350	1.72	14"
5-03-79	832+34-839+46	E.B.(Outside)	156	22	3:4	200	150	350	2.24	14"
5-07-79	839+46-846+26	E.B.(Outside)	154	16	3:4	200	150	350	2.27	14"
5-08-79	846+26-854+66	E.B.(Outside)	199	11	3:4	200	150	350	1.76	14"
5-09-79	854+66-862+10	E.B.(Outside)	185	6	3:4	200	150	350	1.89	14"
5-10-79	862+10-868+62	E.B.(Outside)	163	-	3:4	192	144	336	2.06	14"
5-14-79	868+62-876+08	E.B.(Outside)	164	30	3:4	160	120	280	1.71	14"
5-15-79	876+08-881+56	E.B.(Outside)	109	16	3:4	120	90	210	1.93	14"
5-16-79	881+56-885+04	E.B.(Outside)	75	13	3:4	96	72	168	2.24	14"

PRESSURE GROUT (Flyash-Cement)

Date	Location	Lane	Holes Pumped	Holes Did Not Pump	Ratio	Cement Used Bags	Flyash Used Bags	Total Bags /Day	C.F. /Hole Pumped	Approx. Hole Depth.
5-18-79	928+00-930+28	E.B.(Outside)	11	42	3:1	5	15	20	1.82	8"
5-23-79	836+59-839+00	W.B.(Outside)	78	2	3:1	34	102	136	1.74	14"
5-24-79	833+76-836+59	W.B.(Outside)	69	2	3:1	39	117	156	2.26	14"
5-30-79	830+08-833+76	W.B.(Outside)	93	-	3:1	40	120	160	1.72	14"
5-31-79	826+44-827+16	W.B.(Outside)	88	1	3:1	40	120	160	1.82	14"
6-04-79	820+00-826+36	W.B.(outside)	147	13	3:1	80	240	320	2.8	14"
6-05-79	811+52-819+96	W.B.(Outside)	214	-	3:1	110	330	440	2.06	14"
6-06-79	802+36-811+52	W.B.(Outside)	227	-	3:1	120	360	480	2.11	14"
6-07-79	797+00-811+36	W.B.(Outside)	134	-	3:1	70	210	280	2.09	14"
6-11-79	821+40-834+08	W.B.(Inside)	311	6	3:1	160	480	640	2.06	14"
6-12-79	811+44-821+36	W.B.(Inside)	236	15	3:1	138	414	552	2.34	14"
6-13-79	803+04-811+44	W.B.(Inside)	208	2	3:1	105	415	520	2.50	14"
6-14-79	820+04-832+24	E.B.(Inside)	308	-	3:1	160	480	640	2.08	14"
6-15-79	832+28-841+12	E.B.(Inside)	226	1	3:1	108	324	432	1.91	14"
6-18-79	841+20-842+00	E.B.(Inside)	196	7	3:1	83	249	332	1.69	14"
6-18-79	858+00-864+96	E.B.(Inside)	196	7	3:1	83	249	332	1.69	14"
6-19-79	31+00- 41+00	E.B.(Outside)	249	-	3:1	140	420	560	2.25	14"
6-20-79	83+02- 90+78	E.B.(Outside)	189	9	3:1	98	294	392	2.07	14"
6-21-79	81+00- 88+00	W.B.(Outside)	149	27	3:1	83	249	332	2.23	14"
6-22-79	1113+32-1119+00	W.B.(Outside)	134	8	3:1	66	198	264	1.97	14"
6-25-79	1110+60-1113+28	W.B.(Outside)	63	4	3:1	26	78	104	1.65	14"
6-26-79	900+28-909+00	W.B.(Outside)	203	17	3:1	106	318	424	2.09	14"
6-27-79	892+00-900+28	W.B.(Outside)	205	2	3:1	80	240	320	1.56	14"