

FILE 8-195

PLAINTIFF'S EXHIBIT

CT-1442

April 27, 1956

Mr. Buczkowski:

SUBJECT: The Value of Pulverized Waste in
the A/C Pipe Furnish

Several weeks ago, you and Mr. Lanz discussed at considerable length the Value of Pulverized Waste in the A/C Pipe Furnish. As a result of your conversation, some experimental runs were made at Santa Clara in order to get data on the subject. The data has now been secured and based on it, together with other information, Mr. Lanz has prepared a report on the Value of Pulverized Waste in the A/C Pipe Furnishes. His report is attached hereto. You will find it very interesting. Based upon the information therein, it is my recommendation that we change the Making Particulars for St. Louis and Santa Clara to limit the amount of Pulverized A/C Waste returned to the pipe at those plants to a maximum of six per cent, and at Ambler to a maximum of ten per cent. Before going forward with the change, will you please advise if you would accept this recommendation.

Clyde R. Hutchcroft
Clyde R. Hutchcroft

CRH:ec

Att.

cc - Messrs. Buczkowski (2)

- ✓ Muehlock
- ✓ Maloney
- ✓ Angstadt
- ✓ Meek
- ✓ Ostrowski

Naaman Rhoades

- ✓ Taylor
- ✓ Gear
- ✓ Maco
- Malone
- ✓ Hinkel
- ✓ Lanz ✓
- File

CTD001020

FILE 8-195

April 27, 1956

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- ✓ Lanz ✓
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CTD001021

April 27, 1956

**SUBJECT: The Value of Pulverized Waste in
the A/C Pipe Furnish**

Summary:

Pulverized Waste when added to the A/C Pipe furnish reduces the density of the finished pipe and thereby reduces strength. Additional fiber reinforcement must be added when the amount of Pulverized Waste is increased to overcome the loss of strength due to the lowered density. It was determined that the cost of the additional fiber nearly if not completely offsets the savings due to the use of Pulverized Waste. Because the use of Pulverized Waste in the furnish results in lower density pipe, and because low density pipe are a potential source of difficulty due to weepage and/or leakage, and because it costs little if any more to make higher density pipe by minimizing the use of Pulverized Waste, it is recommended that the use of Pulverized Waste be limited to a maximum of six per cent at St. Louis and Santa Clara. At Ambler, where higher densities are obtained because no silica is used in the furnish, it is recommended that the use of Pulverized Waste be limited to a maximum of ten per cent. It is not recommended that Pulverized Waste be eliminated from the A/C Pipe furnish because it is desirable to use as much scrap as possible to prevent it from accumulating and also, some Pulverized Waste in the furnish undoubtedly aids formation and filtration.

History:

Several months ago, I discussed with Mr. Buczkowski the problem of determining a proper value to place upon Pulverized Waste when it is used in a furnish for A/C Pipe. I was of the opinion that, since Pulverized Waste had been found to have a relative value of 5 in Laboratory tests, it should be possible to use 100 pounds of Pulverized Waste to replace 5 pounds of C&G/3 (relative value = 100) and 95 pounds of cement-silica mix (57 pounds cement and 38 pounds silica). Using Santa Clara costs, for example, the value of 100 pounds of Pulverized Waste would be calculated as:

$$(5)(.1712) + (57)(.0089) + (38)(.0068) = \$1.62 \text{ or } 0.0162 \text{ per pound}$$

At Santa Clara, no financial value is given to Pulverized Waste. Thus, for each pound of Pulverized Waste used over and above the amount in the standard furnish, a profit of 0.0162 should result. If Plant No. 6 used 100 tons of Pulverized Waste in a month, this should represent a saving of \$3,240 over the cost of furnishes if no Pulverized Waste had been available.

$$(100)(2000)(0.0162) = \$3,240$$

Mr. Buczkowski questioned whether we had any data to prove the foregoing hypothesis, and, having none, we agreed to ask Mr. C. R. Meek to make a trial run at Santa Clara in which Pulverized Waste with an assumed relative strength of 5 would be used to replace a calculated equivalent amount of fiber, cement and silica.

CTD001022

Discussion:

During the experimental run which was made, the fiber blend in use was C&G/3, 625 pounds; C&G/4, 375 pounds; and Blue 375 pounds. An experimental furnish, No. 54S was used with a regular production furnish, No. 54. These were:

	No. 54	No. 54S			%
Fiber blend, pounds	273 13.9	264	15.4	1302	94.5
Pulverized waste, pounds	107 5.24	257	15.6	75	5.4
Cement, pounds	800	715			
Silica, pounds	533	477			
Total	1713	1713			

Furnish No. 54S is identical to furnish No. 54 except that 9 pounds of fiber, 85 pounds of cement, and 56 pounds of silica have been replaced with 150 pounds of Pulverized Waste. The effectiveness of furnish for both No. 54 and No. 54S is 1377 which means the 150 pounds of Pulverized Waste with a relative value of 5 has a calculated reinforcing value equal to the 9 pounds of fiber blend plus the 85 pounds of cement and the 56 pounds of silica.

The two furnishes were made into 6 inch, Class 150 pipe using identical beam pressures for both furnishes. Original data obtained by Mr. Meek are shown on the attached data sheet. Average strength values for the two furnishes are shown in the following table.

	Average Values	
	No. 54	No. 54S
Bursting Pressure, P.S.I.	777	733
Mod. of Rupture, Bursting, P.S.I.	3570	3300
Crushing Load, Lbs. Per Ft.	8520	7990
Mod. of Rupture, Crushing, P.S.I.	7700	7140
Density, P.C.I.	0.0624	0.0606

An examination of these average values shows that pipe made with the experimental furnish were weaker in bursting and crushing than pipe made with the regular furnish but also that the experimental pipe were lower in density than the regular pipe. Three conclusions are possible: (1) the experimental pipe were weaker because the Pulverized Waste was not the equivalent of the fiber, cement and silica for which it was substituted, or (2) the experimental pipe were weaker only because the density was lower, or (3) the experimental pipe were weaker because of a combination of (1) and (2).

It has been found in both the T&N and K&M Laboratories that, when other factors are held constant, the strength of an asbestos-cement product is proportional to the square of the density. Thus we can estimate what strength values would have been found for No. 54 if the density had been exactly 0.0620 pounds per cubic inch by

multiplying the values actually obtained by $(0.0620)^2/(0.0624)^2$. Similarly, the values for No. 548 can be corrected to a density of 0.0620 pounds per cubic inch by multiplying by $(0.0620)^2/(0.0606)^2$. The calculated strength values for both furnishes at a density of 0.0620 pounds per cubic inch are shown in the following table:

	Calculated Values at 0.0620 P.C.I.	
	No. 54	No. 548
Bursting Pressure, P.S.I.	767	767
Mod. of Rupture, Bursting, P.S.I.	3520	3450
Crushing Load, Lbs. Per Ft.	8410	8360
Mod. of Rupture, Crushing, P.S.I.	7600	7470

The values are remarkably close, being within two per cent of each other in all cases. It is now possible to say with some assurance that the right conclusion is the second one: (2) the experimental pipe were weaker only because the density was lower. From this we can infer that, if density can be maintained constant, a relative value of 5 for Pulverized Waste is correct and 100 pounds of Pulverized Waste can be considered the equivalent of 5 pounds of C&G/3 and 95 pounds of cement-silica mix in furnishes for A/C Pipe.

In this run, the furnish with the largest percentage of Pulverized Waste had the lowest density; we have noted in several experimental runs that the addition of Pulverized Waste to pipe furnishes has resulted in reduced density. From the meager data which were available, I estimated that the use of one per cent Pulverized Waste reduces the density of A/C Pipe by 0.00025 pounds per cubic inch (the value for this run was 0.00021 P.C.I.). Thus, in A/C Pipe, we cannot add Pulverized Waste to the furnish and maintain constant density; this complicates the question of the value of Pulverized Waste in the furnish for A/C Pipe.

If other factors are constant, the strength of an asbestos-cement product depends on the effectiveness of furnish and the density. The use of Pulverized Waste in the pipe furnish adds to the effectiveness of furnish by the relative value of 5 but reduces the density by 0.00025 pounds per cubic foot for each one per cent used; these two factors tend to offset one another, the relative value of 5 tending to increase strength and the reduction in density tending to reduce strength. To determine the net effect of Pulverized Waste on the breaking strength of pipe an empirical equation was developed. (See Appendix). By using this equation it was possible to calculate the estimated bursting pressures for 6 inch, Class 150 pipe made from furnishes using varying amounts of the fiber blend and Pulverized Waste, all furnishes having the same effectiveness of furnish; calculated values are shown in the following table:

Per cent Fiber Blend	Per cent Pulverized Waste	Effectiveness of Furnish	Calculated Density of Pipe Lbs./Cu. In.	Calculated Bursting Press. PSI 6" Class 150
15.31	0	1377	0.0540	804
16.01	5	1377	0.0628	772
15.71	10	1377	0.0615	741
15.42	15	1377	0.0602	710
15.12	20	1377	0.0590	680

It is evident from this table that the net effect of adding Pulverized Waste and retaining a constant effectiveness of furnish is to reduce density and bursting pressure.

If Pulverized Waste is added to replace cement and silica, the effectiveness of furnish is increased but despite this, the calculated bursting pressure still falls off with increased percentages of Pulverized Waste as shown in the following table:

Per cent Fiber Blend	Per cent Pulverized Waste	Effectiveness of Furnish	Calculated Density of Pipe Lbs./Cu. In.	Calculated Bursting Press. PSI 6" Class 150
15.94	0	1346	0.0640	788
15.94	5	1371	0.0628	768
15.94	10	1396	0.0615	749
15.94	15	1421	0.0602	730
15.94	20	1446	0.0590	709

From the preceding two tables, it is evident that the per cent fiber blend must be increased with increasing amounts of Pulverized Waste if strength is to be maintained. This is shown in the following table which gives the per cent fiber blend required with varying amounts of Pulverized Waste to obtain a calculated bursting pressure for 6 inch, Class 150 pipe of 750 pounds per square inch.

Per cent Fiber Blend	Per cent Pulverized Waste	Effectiveness of Furnish	Calculated Density of Pipe Lbs./Cu. In.	Calculated Bursting Press. PSI 6" Class 150
15.04	0	1270	0.0640	750
15.48	5	1332	0.0628	750
15.96	10	1398	0.0615	750
16.49	15	1468	0.0602	750
17.08	20	1542	0.0590	750

On the attached sheet are shown several graphs which are of interest. Graph No. 1 shows how the density drops as the per cent Pulverized Waste is increased. Graph No. 2 shows how much the fiber has to be increased as the per cent Pulverized Waste is increased in order to maintain a bursting pressure of 750 pounds per square inch. Graph No. 3 shows the furnish cost per pound to retain a bursting pressure of 750 pounds per square inch. Two curves are shown: one for Pulverized Waste at 0.0050 per pound and one for Pulverized Waste at no value. Plant No. 6 has set up Pulverized Waste at no value but

this is obviously fictitious; Mr. Hedrick estimates a fair value as 0.005 per pound. While cost of furnish per pound increases with increasing percentages of Pulverized Waste, the density decreases; the net effect is plotted on Graph No. 4 which shows the cost of furnish per foot of 6 inch, Class 150 pipe. With cost of Pulverized Waste at zero, the cost of furnish per foot of pipe does decrease with increasing percentages of Pulverized Waste; this is, however, at the expense of density which is reduced as shown in Graph No. 1. With the cost of Pulverized Waste at 0.005 per pound which is believed to be more realistic, the cost of furnish per foot of pipe decreases very slightly with increasing amounts of Pulverized Waste up to about five or six per cent and thereafter remains essentially constant. Thus, above about five or six per cent, it is not an economy to use Pulverized Waste at Santa Clara; it is actually detrimental because of the lower density and the likelihood of receiving complaints on weepage and/or leakage. The same conclusion applies to St. Louis which also uses an autoclave furnish. It is interesting to speculate whether one of the reasons that Santa Clara has been able to use considerably cheaper furnishes than St. Louis is due to the use of about six per cent Pulverized Waste at Santa Clara and about twice this amount at St. Louis. Plant 8 can probably afford to use slightly more Pulverized Waste, say up to ten per cent, because of the inherent higher density of the normal cure furnish. The use of some Pulverized Waste in the furnish is desirable, not only to prevent the accumulation of scrap but also because it probably aids in formation and filtration.

Recommendations:

Because the use of Pulverized Waste in the furnish results in lower density pipe, because low density pipe are a potential source of difficulty due to weepage and/or leakage, and because it costs little if any more to make higher density pipe by minimizing the use of Pulverized Waste, it is recommended that the use of Pulverized Waste be limited to a maximum of six per cent at St. Louis and Santa Clara and a maximum of ten per cent at Ambler.

R. L. Lanz
R. L. Lanz

RLL:ec
Att.

A P P E N D I X

In his work on fiber evaluation, Mr. J. A. Malone has developed an equation:

$$S = 33.4 + 0.149 (RF + 5W).$$

where S = breaking load of the pressed cake used for determining the relative strength of the fiber, pounds.

R = relative strength of the fiber.

F = per cent fiber in the furnish.

W = per cent Pulverized Waste in the furnish.

Assume that the bursting pressure of a 6 inch, Class 150 pipe is proportional to the strength of the furnish and therefore is proportional to the breaking load of Mr. Malone's pressed cake.

$$B = aS$$

where B = bursting pressure of a 6 inch, Class 150 pipe, PSI.

a = constant

substituting, $B = a(33.4 + 0.149 RF + 0.745 W)$.

We know that strength is proportional to the square of the density and we have also estimated that the density of pipe made at Santa Clara without Pulverized Waste would be about 0.064 pounds per cubic inch. A factor correcting for density $(D/0.064)^2$ can thus be introduced.

$$B = a(33.4 + 0.149 RF + 0.745 W)(D/0.064)^2$$

where D is the density of pipe in pounds per cubic inch.

From several experimental runs we have estimated that one per cent Pulverized Waste reduces the density by 0.00025 pounds per cubic inch. If pipe made without waste is 0.064 pounds per cubic inch, $D = 0.064 - 0.00025 W$.

Substituting for D.

$$B = a(33.4 + 0.149 RF + 0.745 W)(0.064 - 0.00025 W)^2 / (0.064)^2$$

$$\text{Simplifying, } B = a(33.4 + 0.149 RF + 0.745 W)(1 - 0.004 W)^2$$

The data for five experimental runs of six inch, Class 150 pipe was inserted in the above formula and five values of "a" were determined: 3.43, 3.43, 3.04, 3.35, and 3.45. The value of 3.04 was discarded and the remaining four values averaged to give a = 3.41.

Substituting and simplifying we get the equation:

$$B = (115 + 0.5 RF + 2.5 W)(1 - 0.004 W)^2$$

This is the formula which was used to calculate the data in the tables in the body of the report.

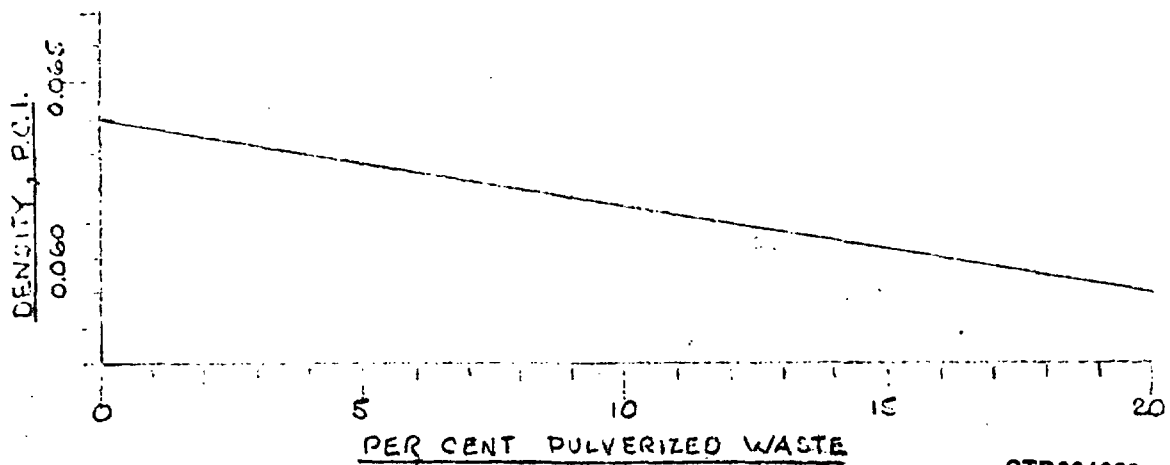
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DATA SHEET

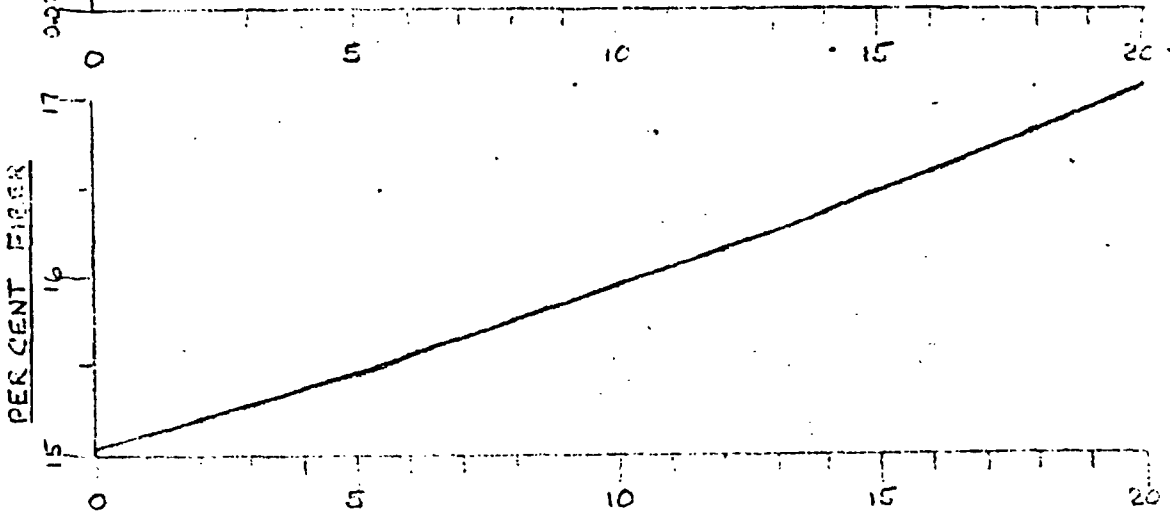
SUBJECT: EXPERIMENT TO DETERMINE THE EFFECT OF A/C FINES IN FINE
 PLANT No. 6, SANTA CLARA, CALIFORNIA
 REFER TO: LETTER, ABOVE SUBJECT, DATED JAN 16, 1956; TO R. LANE FROM R. HAERTMAN

TEST RUN	TEST PIPE NO.	ROLL-UP TIME MIN.	BRAM PRES. START-FINISH PSI	HYDRASTATIC BURST PRES. PSI	MODULUS OF RUTURE (BURST) PSI	CRUSHING LOAD (K3/14) PSI	MODULUS OF RUTURE (K3/14) PSI	"C" SAMPLE DENSITY (LBS/CU IN.)
FURNISH No. 54	124	0.40	125 - 30	525	3650	9270	8200	0.0622
	135	0.40	125 - 30	755	3520	8420	8190	0.0632
	146	0.26	125 - 30	745	3380	8210	7450	0.0610
	154	0.20	125 - 30	720	3320	8010	7540	0.0625
	167	0.20	125 - 30	800	3720	8270	7440	0.0617
	175	0.20	125 - 30	750	3400	8240	7220	0.0614
FURNISH No. 54S	230	0.33	125 - 30	690	3030	7310	6520	0.0598
	236	0.35	125 - 30	700	3140	8190	7350	0.0595
	244	0.35	125 - 30	615	3120	7270	6720	0.0601
	255	0.35	125 - 30	725	3520	8420	7320	0.0615
	263	0.35	125 - 30	700	3200	9210	8420	0.0615
	273	0.35	125 - 30	710	3160	7910	6760	0.0606
	286	0.35	125 - 30	720	3510	7110	6470	0.0620
	291	0.34	125 - 30	765	3430	7210	7240	0.0602
	298	0.35	125 - 30	800	3540	7220	6400	0.0605
	303	0.37	125 - 30	760	3320	8210	7250	0.0624
	310	0.35	125 - 30	775	3520	7120	6410	0.0625
	315	0.35	125 - 30	725	3150	7470	6600	0.0610
FURNISH No. 54	320	0.20	125 - 30	805	3270	9320	8020	0.0623
	370	0.20	125 - 30	820	3670	7100	6620	0.0625
	375	0.20	125 - 30	770	3510	7100	7140	0.0631
	381	0.33	125 - 30	840	3260	9100	7230	0.0625
	385	0.33	125 - 30	720	3270	8210	7610	0.0620
	390	0.20	125 - 30	815	3650	9440	8530	0.0626

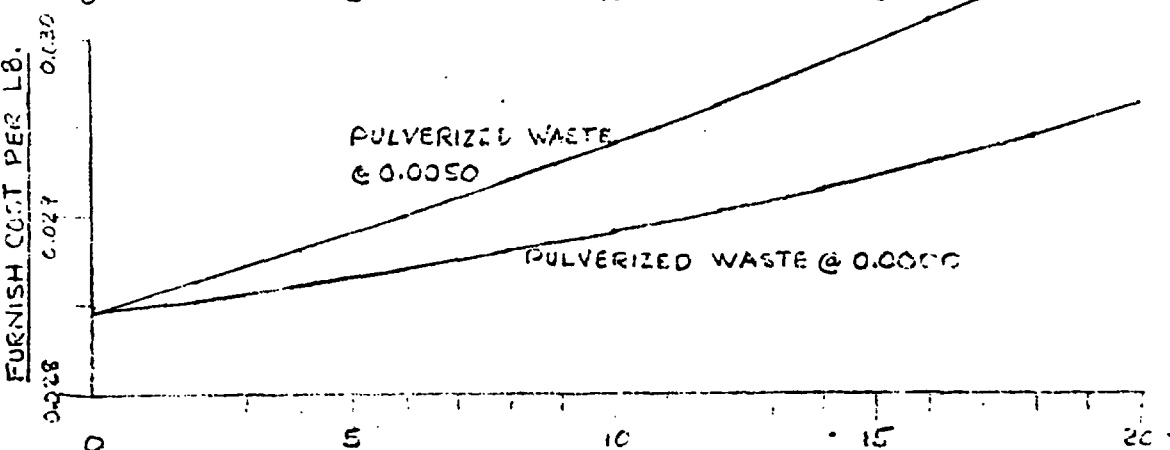
GRAPH NO. 1



GRAPH NO. 2



GRAPH NO. 3



GRAPH NO. 4

