PLAINTIFF'S EXHIBIT

CAP-840

United States Testing Company, Inc.

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REPORT OF TEST

A comparison of flexure and crushing tests on ten (10) foot and thirteen(13) foot lengths of 4 inch 1500 pound class Building Sewer Pipe.

October 10,1963 P-23570

Certain-Teed Products Corporation
Plant #58
Ambler, Pa.

SIGNED FOR THE COMPANY

BY Glenn E. Burkit

PURPOSE

To compare through actual analysis the flexure, deflection and crushing strength of Ten (10) foot and Thirteen (13) foot lengths of Building Sewer Pipe.

MATERIALS

Described by client as autoclaved asbestos - cement building sewer pipe.

SAMPLING

From a tray of Seventy-five (75) pipes, Twenty-four (24) were selected at random and numbered consecutively from 1 through 24. The even numbered pipes were tested as sampled. The odd numbered pipes were reduced to a ten (10) foot length by cutting 1½ feet from each end.

TEST CONDITIONS

The tests were conducted under the direct supervision of a representative of the United States Testing Company on October 10, 1963 at Certain-teed Products Corporation, Plant #58, Ambler, Pa.

The flexure tests were conducted on a Tinius Olson Flex Tester and the crushing tests were conducted on a Racine-Seco Crushing Tester.

TEST METHOD

1. The twelve (12) even numbered thirteen (13) foot pipe were individually tested on a Tinius Olsen Flex Tester to destruction on a twelve (12) foot span, third point loading. Recorded during continuous uniform loading were the load at destruction, the deflection at destruction and the deflection at 415 pound test load.

2. The twelve (12) odd numbered ten (10) foot pipe were individually tested on a Tinius Olsen Flex Tester to destruction on a nine (9) foot span, third point loading. Recorded during continuous uniform loading were the load at destruction, the deflection at destruction and the deflection at a 550 pound test load.

3. Crushing Tests were then conducted on six (6) of the flexure tested pipes of each length according to the procedures of ASTM C 428-63T.

UNITED STATES TESTING COMPANY, INC.

RESULTS

1. THIRTEEN (13) FOOT PIPE

Sample Number	Deflection at 415 pounds	Deflection at Break	Breaking Load	Crushing
2	.70	.80	490	
4	.75	1.15	690	3434
6	.75	1.00	600	
8	.80	1.18	700	3336
10	.73	1.00	600	
12	.75	1.10	680	2649
14	.68	1.05	720	
16	.70	1.10	660	2846
18	.53	.93	680	
20	.78	1.10	670	2846
22	.75	1.03	620	
24	.68	1.00	650	3297
Averages	.72	1.04	647 pounds	3068 pounds/ft.

2. TEN (10) FOOT PIPE

Sample Number	Deflection at 550 lbs.	Deflection at Break	Breaking Load	Crushing
1	.50	.63	790	
3	.43	.60	970	2944
5	.43	.60	900	
7	.45	.60	880	3474
9	.45	.58	820	
11	.45	.70	990	3238
13	.43	.73	1040	
15	.45	.73	1050	3042
17	.43	.48	610	
19	.43	.75	1110	2846
21	.40	.68	1020	2551
23	.45	.65	920	
Averages	.44 inches	.64 inches	925 pounds	3016 pounds/ft.

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Flex Values For 10' & 13' Lengths Of Asbestos-Cement Pipe

Each length of Asbestos-Cement Pipe manufactured, in sizes 3" through 8", must meet a strength requirement for beam action. This may be expressed as uniformly distributed load per lineal foot or Modulus of Rupture in Flexure.

To proof test the beam action of pipe in our plants, either uniformly distributed load per lineal foot or Modulus of Rupture are converted to third point concentrated loading. A Tinius-Olsen Flex Testing Machine is standard equipment in the industry for such testing and all our plants are so equipped.

The formula for converting Modulus of Rupture and uniformly distributed load per lineal foot to third point loading is shown on attached Page No. 1.

On Page No. 2 the Modulus of Rupture formula is used to calculate the flex test load for 4" Class 1500 Building Sewer Pipe. The calculations are based on our concept of flex values and show the flex load for 13' lengths to be 9/12 the load for 10' lengths. The 13' pipe to be tested on a 12' span and the 10' pipe to be tested on a 9' span.

Page No. 3 uses the standard beam formula to calculate the factory flex test load. Again these calculations are based on our concept of flex values and show 13' pipe to be equal to 10' pipe when the flex load for 13' length is 9/12 the load for 10' length.

Page No. 4 shows how much greater 13' lengths of Building Sewer Pipe would have to be designed in order to be equal to 10' lengths according to the J-M concept of flex strength. This is based on Modulus of Rupture.

Page No. 5 shows how much greater 13' lengths of Building Sewer Pipe would have to be designed in order to be equal to 10' lengths according to the J-M concept of flex strength. This is based on uniformly distributed load per lineal foot.

MODULUS OF RUPTURE

$$\text{STRESS} = \frac{Pl}{\frac{\pi}{32}\left(\frac{D^4 - d^4}{D}\right)} = \frac{32}{\pi \times 6} \frac{PlD}{(D^4 - d^4)}$$

$$= \frac{32}{6 \times \pi}$$

$$= \frac{32}{18.85} \frac{PlD}{(D^4 - d^4)}$$

$$= \frac{1.70 \times P \times l \times D}{(D^4 - d^4)}$$

P = Total Load

l = Span

D = Outside Diameter

d = Inside Diameter

STANDARD BEAM FORMULA

$$F = \frac{Wl^2}{4a}$$

F = Total Factory applied load

W = Uniformly Dist. Load/Lin. Ft.

l = Length of Pipe

a = Distance from support to half load applied at third point.

CASE NO. 2

FLEX TEST LOAD BASED ON MODULUS OF RUPTURE

4" Class 1500 D/S Pipe	CPC Pipe	J-M Pipe
Inside Diameter	4.00	4.00
Outside Diameter	4.58	4.58
Flex Test Load	(13') 415	(10') 550

J-M PIPE

SIZE	CLASS	LEN.	FLEX LOAD SPAN				MODULUS OF RUPTURE
4	1500	4'	$\frac{1.70 \times 1647 \times 36 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514
4	1500	5'	$\frac{1.70 \times 1238 \times 48 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514
4	1500	6'	$\frac{1.70 \times 990 \times 60 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514
4	1500	10'	$\frac{1.70 \times 550 \times 108 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514

CPC PIPE

SIZE	CLASS	LEN.	FLEX LOAD SPAN				MODULUS OF RUPTURE
4	1500	4'	$\frac{1.70 \times 1650 \times 36 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{\cancel{462488}\ 465291}{1840}$	=	2529
4	1500	5'	$\frac{1.70 \times 1240 \times 48 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{\cancel{462488}\ 465291}{1840}$	=	2529
4	1500	6'	$\frac{1.70 \times 995 \times 60 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{\cancel{462488}\ 465291}{1840}$	=	2529
4	1500	10'	$\frac{1.70 \times 554 \times 108 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{\cancel{462488}\ 465291}{1840}$	=	2529
4	1500	13'	$\frac{1.70 \times 415 \times 144 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{\cancel{462488}\ 465291}{1840}$	=	2529

RECAP

PIPE LENGTH	4'	5'	6'	10'	13'
CPC FLEX TEST LOAD	1650	1240	995	554	415
J-M FLEX TEST LOAD	1647	1238	990	550	—
	3	2	5	4	

FLEX TEST LOAD BASED ON MODULUS OF RUPTURE

4" Class 1500 B/S Pipe	CPC Pipe	J-M Pipe
Inside Diameter	4.00	4.00
Outside Diameter	4.58	4.58
Flex Test Load	(13') 750	(10') 550

J-M PIPE

SIZE	CLASS	LEN.	FLEX LOAD SPAN				MODULUS OF RUPTURE
4	1500	4'	$\frac{1.70 \times 1647 \times 36 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514
4	1500	5'	$\frac{1.70 \times 1238 \times 48 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514
4	1500	6'	$\frac{1.70 \times 990 \times 60 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514
4	1500	10'	$\frac{1.70 \times 550 \times 108 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{462488}{1840}$	=	2514

CPC PIPE

SIZE	CLASS	LEN.	FLEX LOAD SPAN				MODULUS OF RUPTURE
4	1500	4'	$\frac{1.70 \times 3000 \times 36 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{840888}{1840}$	=	4570
4	1500	5'	$\frac{1.70 \times 2250 \times 48 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{840888}{1840}$	=	4570
4	1500	6'	$\frac{1.70 \times 1800 \times 60 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{840888}{1840}$	=	4570
4	1500	13'	$\frac{1.70 \times 750 \times 144 \times 4.58}{4.58^4 - 4.00^4}$	=	$\frac{840888}{1840}$	=	4570

RECAP

PIPE LENGTH	4'	5'	6'	10'	13'
CPC FLEX TEST LOAD	3000	2250	1800	1000	750
J-M FLEX TEST LOAD	1647	1238	990	550	——
	1353	1012	810	450	
	82%	82%	82%	82%	

UNIFORMLY DISTRIBUTED LOAD PER LIN. FT. BASED ON STANDARD BEAM FORMULA

J-M PIPE

SIZE	CLASS	LEN.	UNIFORMLY DIST. LOAD PER LIN. FT. LENGTH		FLEX LOAD
4	1500	4'	$\frac{412 \times (4)^2}{4 \times 1}$	=	1647
4	1500	5'	$\frac{264 \times (5)^2}{4 \times 1.333}$	=	1238
4	1500	6'	$\frac{183 \times (6)^2}{4 \times 1.666}$	=	990
4	1500	10'	$\frac{66 \times (10)^2}{4 \times 3}$	=	550

CPC PIPE

SIZE	CLASS	LEN.	UNIFORMLY DIST. LOAD PER LIN. FT. LENGTH		FLEX LOAD
4	1500	4'	$\frac{750 \times (4)^2}{4 \times 1}$	=	3000
4	1500	5'	$\frac{479 \times (5)^2}{4 \times 1.333}$	=	2250
4	1500	6'	$\frac{333 \times (6)^2}{4 \times 1.666}$	=	1800
4	1500	10'	$\frac{120 \times (10)^2}{4 \times 3}$	=	1000
4	1500	13'	$\frac{71 \times (13)^2}{4 \times 4}$	=	750

RECAP

		4'	5'	6'	10'	13'
CPC	(UNIFORMLY DISTRIBUTED	750	479	333	120	71
J-M	(LOAD PER LIN. FT.)	412	264	183	66	—
		338	215	150	54	
		82%	82%	82%	82%	

CA

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AN OLD OLD STORY

The following was just taken from the records of the Archeological Department of a University in the East, being a translation of a recently acquired bit of papyrus which was written some 4,000 years ago. It is the report of the Egyptian official to the Pharaoh.

"Know, Oh Mighty Pharaoh, that I have made inspection of the works of the upper Nile. I found the builders to be a strange breed. First cometh the man with three-legged prong with which they make divers observations. When they approach a village, the maidens fleeth and the villagers bewail exceedingly because they aim the prong at a house, saying it must be moved, although the desert stretches for miles around, desolate. Sometimes the prong men drive little stakes into the ground. They play a game and wait until someone knocks down one of the stakes, and they, the prong men, jump in the air and shout and tear their hair and call on Ea and Orirs and Iris and Set and Horos and all the lesser gods, and they become exceedingly wrath, all about little sticks. They also make many heiroglyphics, many of which they do not understand themselves."

"Then cometh the contractors. They are a class that have many posessions and ride in fine chariots, but easily run to bitter tears; and they runneth down the work to be done, to each other, that they make the other afraid and he addeth much expense to the calculations."

"Then cometh the materials man clotheth in fine apparel, and the maidens meet them with gleeful smiles, as they have something magic called "expense accounts". They are all worshippers of the Sacred Bull. Every morning they chant, "Oh Sacred Bull, keep us full of they substance because only with thee can we make a living".

"Then cometh the letting of the contract. Whereat one contractor draws the prize and the rest of the contractors beat their breasts and pour ashes on their heads, and say with a mighty shout, "He can't do it for the money". Always they have said this, and always to the end of time they will say it, even until the stars grow cold.

"But the low bidder, he smiles and is pleased with himself, wise in his own conceit and he hunteth up the three-prong men and taketh them to dine with him and handeth the check to the material man."

THE END

Manufacturers of PERMAFLEX Water and Sewer Pipe

The following pages are "Salesmen's Remarks on

10 vs. 13-ft. Lengths."

I would go the the Engineer's Office and I would tell the Engineer that only one manufacture (in this country) furnish 10' lengths. Most engineers are not aware of this and when they hear this they will open up the specification, also if a federal money job, he has to open the job to all that meet specifications.

*Note: JM and FK make 10' pipe.

I would go to the Engineer's Office and present him with a copy of ASTM or AWWA Specifications (assuming he doesn't have one) then enter into a discussion of the responsible agencies behind the specs. Might drop a remark or so about the waterworks industry suffering from the fact that J/M saddled themselves with 10' machines years ago to make conduit, etc., and could not market the output, so to protect their investment they try to force the use of Watermain on the Engineers and Contractors. Then I would tell the Engineer that the contractor is not worried, and the contractor is responsible, plus we are behind the contractor in supplying quality pipe.

I would go to the Engineer's Office and ask him to allow 13', I would stress the fact that we had many jobs in service of 4" - 13' and that they had all been free from flex breaks. I would tell him that I would like to place a call to contractors whom he knew had used our 13' for a testimonial. If he still refused, I would ask the contractor to use our price with a qualifying letter.

I would go to the Engineer's Office and point out to him the accounts in the immediate area using 13' pipe for virtually an identical application. I would endeavor to find out why he has written in this application, letting him explain the supposedly good, exclusive features of 10' lengths of pipe. When he finally comes up with one he considers exclusive, I would try to sell him off of this one fact or get an agreement from him that if we quoted 13' lengths and were low we would continue to negotiate after the bid letting. Giving me an opportunity to see the client.

I would go to the Engineer's Office and advise him of previous projects installed where 13' lengths had been used successfully for many years. Furnish him with a list of Engineers, Municipalities, Contractors, etc., who had successful installations in all types of soil conditions. I would then discuss proper installation procedures so as the pipe in the ditch would not act as a beam, etc.

There is 30% more handling of pipe in unloading and laying which causes labor rates to go up, thereby causing bids to be higher which could put the job out of the money. There is 30% more chance of leaks. There is less length of pipe under stress, which means that shorter lengths could break before reaching trench bottom.

If 10-ft. lengths are better than 13-ft., why aren't they manufacturing in larger sizes of pipe?

Could it be that certain companies bought 10-ft. machines to make conduit but lost the conduit market and are trying to take advantage by using adverse publicity?

13-FOOT vs. 10-FOOT

Contractor: "Engineer calls for 10-foot lengths."

Salesman: "Do you have a specific reason for specifying 10-ft. lengths?"

Contractor: "Less breaks."

Salesman: "How can this be stated as a fact?. Did your informant provide this to you in writing? I'd like to see it."

"I'm sorry you don't have anything written."

Contractor: "I have not seen anything written but I've often heard this."

Salesman: "I would like to say this; My worthy competitors have machines to manufacture 10-ft. lengths, not specifically for manufacturing water or sewer pipe but for manufacturing conduit. This business has gone over to plastic and other mediums. Now they have these expensive machines -- what can they use them for? We would manufacture 10-ft. lengths gladly if our Research Department considered it advisable. You see, we don't have this machine. They were originally purchased to manufacture conduit. Since it isn't feasible, we aren't going to spend $250,000. I believe you'll agree with me -- they are trying to sell 10-ft. lengths because they need production on these machines. If there was proof of an engineering value, I can see your specifications. Since we don't have proof, please issue an addendum changing this.

Knowing that Johns-Manville are the only ones that quote 10-ft. lengths in my area, I would approach the engineer with this. I would tell him he would eliminate us and Certain-teed and therefore end up with higher unit prices knowing J-M will quote high.

Also I would inform the engineer of the advantages of the 13-ft. lengths. I would also remind the engineer if Federal money is involved, that the particular agency will not permit this kind of spec writing.

Mr. Engineer:

First of all, I am shocked that you would put out an addendum reducing the lengths of A/C pipe to 10-ft. When you know as well as I do that with the way you call for the bedding of pipe in your specs.

Also, down through the last six years you have never in your past history done this. As you realize, I am sure, that using your specifications as a guide line for installation, my 13-ft. joint is probably the best laying length for the job.

May I point out also that the Federal Specifications specify the 13-ft. length. We meet all the AWWA, ASTM & Federal Specifications. We have passed the Underwriters' Laboratory test and the Pittsburgh Testing Laboratory test, etc.

1. If Federal monies involved,explain discrimination and limited source of supply.

2. Have list of successful installations of 13-ft. lengths giving location, contractor, and name of engineer.

3. Go over completely beam loading and flex strength showing test results.

4. Show difference in flex strength of 10-ft. & 13-ft. lengths. Also explain that if pipe is laid in accordance with AWWA Specs and standard installation practices, there should be no beam action.

Upon seeing the engineer for the first time, I introduce myself. I proceed to ask him his reasons for the 10-ft. lengths only. If his reasons are for poor ground conditions, I would explain that there is no basis for 10-ft. lengths being stronger than 13-ft. Besides, you can actually get more flex in 13-ft. lengths. I would go into the facts that less joints mean less chance for leaks. Also contractor would rather buy 13-ft. because of speed of installation.

There is no question that 13-ft. lengths of pipe is not as good as 10-ft. lengths due to our testing. This pipe meets the specification required. You also gain the footage. I think there is discrimination when 10-ft. lengths are specified.

By definition, the word flexure means ability to bend. The reason bending ability is important is so that pipe which has not been properly bedded can deflect downward without breaking until it gets bearing.

When we flex test our 4-inch pipe in 13-ft. lengths we bend or deflect the pipe 1-3/4" in the test. Our competitors in testing their 10-ft. lengths deflect their pipe only 1". So, we actually deflect pipe 75% more in testing than our competitor.

The important thing for pipe is not to act as a beam but its ability to adapt to adverse conditions without breaking!