LEAD INDUSTRIES ASSOCIATION, INC.

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[illegible]

January 28, 1965

<u>Subject</u>: <u>LEAD JOINTS IN CAST-IRON SOIL PIPE</u>

To Members of the Lead Industries Association, Inc.:

Attached please find a reprint of an article entitled "Will Calked Lead Joints Withstand High Temperatures" that appeared in the December, 1964 issue of PLUMBING, HEATING, COOLING BUSINESS.

The article is a report of the research on calked lead joints being conducted by Prof. H. A. Montgomery, Purdue University, Lafayette, Indiana, under the sponsorship of the International Lead Zinc Research Organization.

The article has been reprinted by L.I.A. in quantity and will be used to handle inquiries and for distribution at our exhibit booth at the Plumbers' Convention.

Copies are available to members in quantities up to 25 free of charge and in larger quantities at our cost of 5 cents per copy.

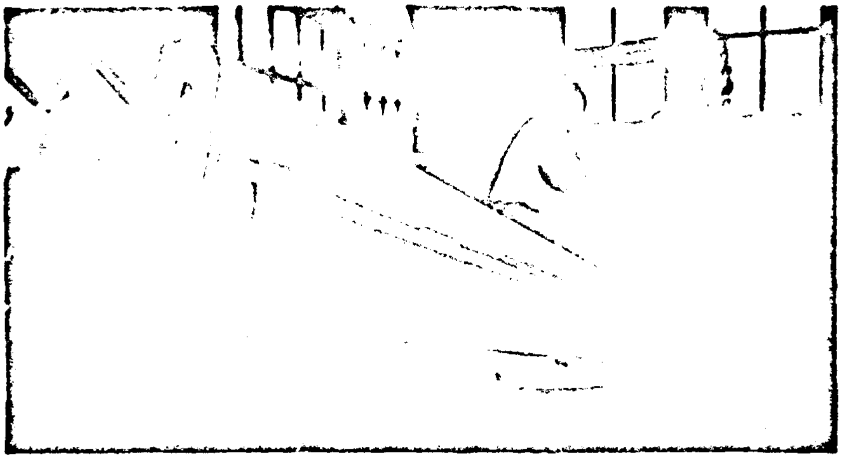
Sincerely yours,

David M. Borcina

David M. Borcina
Secretary

DMB:so
Att:

"Look Ahead with Lead"



Test rig used in study of calked lead joints was designed to duplicate conditions encountered in field installations. Prof. Montgomery is shown recording water pressure and temperature during study

Will Calked Lead Joints Withstand High Temperatures?

The answer is yes, according to findings of a new research study. Tests show that lead-oakum joints in cast iron soil pipe withstand temperatures of 170° F with no leakage. Here is a condensation of the paper presented at the 1964 annual meeting of the American Society of Sanitary Engineering, by the man who conducted the study, Prof. Harold A. Montgomery, School of Technology, Purdue University. Sponsor: International Lead Zinc Research Organization

■ SINCE BEFORE THE Civil War, lead-oakum joints have been the predominant choice for cast iron bell-and-spigot supply and waste lines. U. S. Bureau of Mines records show that over 70,000 tons of lead are now used every year in this application. However, because of the increasing trend toward automatic appliances—which require high temperatures and increased volumes of water—the effectiveness of this joint in waste systems has been questioned.

To establish engineering data on performance of joints at elevated temperatures, for the guidance of the plumbing industry, the International Lead Zinc Research Organization sponsored a research program. Primary objective was to confirm, through laboratory tests, that standard lead-oakum joints in asphaltic-coated cast-iron soil pipe would not leak under high temperature-pressure fluctuations now encountered in domestic applications. Levels of the three prime test criteria—temperatures, pressures and volume of water—were deliberately selected to exceed normal field conditions in order to provide a strong safety margin for specification.

Three standard joints — lead-tarred oakum, single-strand dry jute and white jute were used in the tests. On the basis of results summarized over a one-year period the following conclusions were reached.

Lead-tarred oakum joints withstand temperatures of 170° F at 10 psi with no leakage under the test conditions used.

Tarred oakum is superior to single-strand dry and white jute under high temperature-pressure conditions.

A repeated lateral deflection of 1/16" at pipe joints, due to thermal cycling, does not appear to cause leakage in standard lead-tarred oakum joints.

Utilizing standard practices, lead-tarred oakum joints can be consistently produced which will meet the great majority of service temperature and pressure conditions without leakage.

Pipe coating appears to be a significant factor in leakage at high temperatures. Further tests on uncoated pipe are indicated.

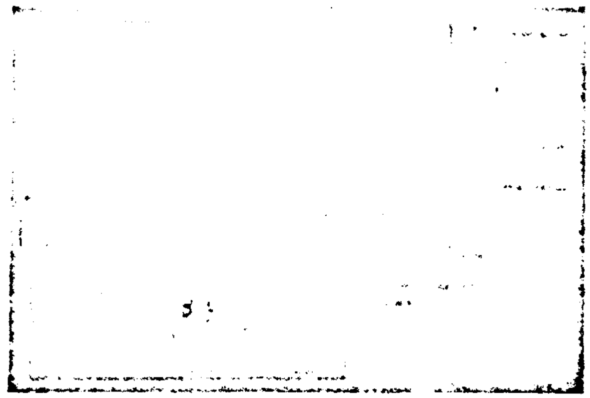
While 170° F is the limiting temperature for lead-tarred oakum joints in coated pipe under the test conditions used, it is extremely remote that in conventional installations there would be a sufficient volume of even hotter water discharge into the system to raise joint temperature to 170° F.

Joint Design for Test

For the test a conventional lead-tarred oakum joint was used. The test joints were prepared by pouring and calking in the conventional manner, with two 5' lengths of 4" service weight, single-hub, coated cast iron pipe held in a clamping jig in a vertical position. The bottom pipe rested on a concrete floor which gave solid backing for the calking.

Care was taken to center the spigot in the bell sections, and to obtain axial alignment of the two pipe sections. The three strands of the oakum were separated and a single strand (3/8" to 1/2" in diameter) used for calking. This is standard practice and facilitated packing of the oakum firmly in place. The oakum was laid in the ... 1" to 1¼" of space was left from the oakum to the top of the bell. All packing was done with standard yarning and calking irons. A hammer weight of 1½ lbs. was used with short, sharp swings to do all calking. In making joints, white jute was the most difficult of the three to pack firmly. The tarred oakum and the single-strand dry oakum were equally easy to calk. Lead used for calking met the requirements of the American Water Works Association, Specification C600-54T.

Molten lead at a temperature of between 780° and 825° F was poured into the joint until level with the top of the bell. The inner circle was calked first and then the outer circle. A second calking pass was made on each joint to assure an even distribution of pressure around the joint.



Test system, shown schematically, permitted flow of either hot or cold water through test specimen. Three-way valve (lower center) served as the key control valve in following procedure for testing the joint

The Test Equipment

In designating the test rig (see photo), rigid clamping of pipe ends was provided to prevent longitudinal movement and simulate a very extreme field condition. Lateral movement of the pipe was not restrained and averaged about 1/16" at the joint during each thermal cycle.

The accompanying diagram shows a schematic of the test system ... either hot or cold water under pressure through the test specimen. A three-way valve (bottom center) served as the key control.

Pressure and temperature were recorded on gages located between the three-way valve and the test specimen. The pressure gage and the thermometer were checked and calibrated so that they would accurately indicate the temperature and pressure at the joint. Pressure was controlled by valves on the discharge end of each flow circuit. Hot water was recycled, cold water discharged to drain, and the temperature of the water controlled through the steam heat exchanger.

A hot water heater was used to bring the water to within a few degrees of the test temperature. Control from that point was rapid and positive. Bleed-off from the pump was necessary to prevent cavitation in the 200° F-plus range of temperatures.

Testing the Joint

Test procedures were as follows:

(1) Fill test system with room temperature water at 10 psi for 20 minutes to simulate conventional, on-the-job testing procedure.

(2) Circulate hot water at 10 psi until the joint reaches test temperature ...

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outer surface of the hub by a tempstick

3. Introduce room temperature water into the system to replace the hot water and circulate until the joint reaches room temperature.

4. Continue to run alternate hot and cold cycles of water at 10 psi until 20 cycles are completed or until a leak occurs.

The initial pressure placed on the joint assembly in the test rig simulated on the job testing to determine whether the joint was pressure tight under the prescribed pressure, usually 5 psi. Pressures used were 10 psi for the standard joint series.

If a leak occurred during this test period, recalking was done in place on the test rig, and the joint again pressurized. If the joint leaked, it was rejected according to test procedure. A recalked joint that is pressure tight is as good as one that is pressure tight on the initial calking, if no defects that cause initial leaks are present (such as cracked hubs, etc.

A complete test run of 20 cycles would mean the joint was under a test pressure of 10 psi for 6 hours and 40 minutes, had reached maximum lateral deflection 20 times, and had undergone thermal cycling 20 times. The time required after water temperature was changed for the joint to reach 160° F from room temperature (74° F), was 3 minutes, 45 seconds. Cooling time, from 160° F back to room temperature, was 4 minutes. There were a few seconds of variation from specimen to specimen.

Test Results

Lead-Tarred Oakum Joints. Tests show that the lead-tarred oakum joints provide excellent performance at a temperature of 170° F at 10 psi. Additional tests undertaken at 180° F at 10 psi, showed conclusively that this was too high a temperature.

The leaks at temperatures above 170° F appear to be caused by the softening of the pipe coating. In almost every instance of water leakage, tar seepage first occurred at the leak site. On some pipe the coating is uneven and lumpy. Leaks would occur in such areas of excess coating. At a surface temperature [illegible] tacky and at 180° F the coating can be moved about under finger pressure. It was also noted in other tests conducted with untarred oakum, which precludes oakum as the source of tar, that tar seepage occurred first, which lends credence to the belief that the pipe coating is a factor in leakage at high temperatures.

Additional testing indicated that the joint will withstand higher pressures at 170° F. Some joint specimens of the lead tarred oakum have been held at 25 psi for periods of from 20 to 120 minutes without leaking. Thus, temperature—not pressure within limits—appears to be the critical factor.

Lead-Single Strand Dry Jute Joints. On the lead-single-strand dry jute joint series, failure of the joints occurred within the first 10 cycles of the test at 160° F. Leaks would usually occur on the side of the joint that was in tension during the hot cycle. There was no definite pattern, however, as to exactly where the leak would occur or the number of leaks. The inside of the joint, however, showed the most leaks.

Lead-White Jute Joint. In tests on lead-white jute joints, the failure of the joint occurred within the first 15 cycles and on the hot water cycle at 160° F. Once water seepage started on the hot cycle, leakage increased progressively. There was no specific pattern for leakage.

Sag Measurements

Sag measurements were made on a number of soil pipe specimens placed on knife-edge supports set 9' apart. Sag at the midpoint of the joint was measured in thousandths of an inch by a dial indicator. Tests were conducted at 70° F ± 5°.

The amount of sag varies from specimen to specimen, with an average of 0.016" in 24 hours, but very little sag from that time on. To obtain extremely accurate results would necessitate finding the exact axial center of the pipe assembly. This is difficult, due to the tolerance allowance of the soil pipe which prevents perfect joint alignment.

The sag movement stops after a relatively short time so exacting measurements are not significant; particularly in view of the fact that sag test specimens were subsequent- [illegible] ture conditions with no initial leakage. The lateral movement under the pressure-temperature test far exceeded that under sag test conditions and the movement was repeated up to 20 times without causing leakage.

Making Good Joints

Generally, the lead should be calked hard enough to be seated firmly on top of the oakum and to enable expansion against both bell and spigot sections of the pipe. The lead ring should be about 1" in depth from the surface of the bell and be well set into the calking groove. The lead seems to work best if poured at between 700° F and 825° F, but it makes little or no difference whether it is calked cold or hot. Calking the inside section of the joint first seems preferable.

Careful workmanship should, of course, be used with all joints, especially when high temperature conditions are anticipated. When proper techniques are utilized, any qualified plumber will have no difficulty in producing leak-tight joints.

A prime consideration is to insure the oakum is packed firmly and evenly to provide a good seat for the lead and prevent it from sinking down below the level of the hub when the lead is calked.

Also, the pipe must be of sound quality with no pin holes or blows, within dimensional tolerance and with an even coating.

Furthermore, oakum must be of a good quality and readily workable. Very little trouble was encountered in this phase.

Moreover, assembly and calking of the joint must be done firmly and evenly so the pressures induced in calking the oakum and lead are evenly distributed within the joint to prevent the joint hub from cracking. Finally, the lead must meet recognized standards for calking lead, such as the AWWA specification.

Temperature-Rise Time Log

The time it takes under test conditions for the pipe to reach test temperature is of the utmost significance from a practical viewpoint. For example, the time involved for the joint to reach 160° F was 3 minutes, 45 seconds; to reach 200° F [illegible] minutes 20 seconds. The [illegible] tity of water flowing through the 1" pipe would be approximately 1000 gpm at a 10' head, or 1400 gpm at a 20' head, to completely fill the pipe and get the same effect as obtained in the test. Test conditions were such that the pipe was placed at a 30° angle so that the whole inner surface would be in contact with the heated water, under pressure. In this way the most severe conditions were obtained.

Furthermore, it is unlikely in most installations that there would be a great enough volume of water discharging in a system at temperature in excess of 170° F to bring the temperature of the joint itself up to the critical 170° F point and raise the pressure to 10 psi.

In view of this, even though a 170° F limit resulted from these experiments, it by no means indicated that higher temperature waters can not be tolerated under service conditions.

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