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PROGRESS REPORT ON

UNDERGROUND PIPE INSULATION

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to

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NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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<u>WICOR</u>

Wicor is the trade name of a material manufactured by the Waterproof Insulation Corporation of Baltimore, Maryland, made by mixing granular particles of rubber (obtained from old tires) and portland cement with water and a small amount of an ingredient to prevent aeration. A Wicor mixture consisting of 33 lbs of rubber and 25 lbs of cement and water is used to make conduit for insulating and protecting underground steam pipes.

The pipe was prepared by wrapping it first with a layer of 1/8 inch thick corrugated paper and then with a layer of asphalt impregnated paper.

A 16 1/2 inch square conduit of Wicor was poured between forms and cured for 28 days. As the Wicor was being poured, two slabs each 8x8x1 inch were cast for laboratory determinations of the thermal conductivity.

At the end of the curing period the conduit was covered with damp earth to a depth of about 6 inches after which steam at 350F was turned into the pipe and held at that temperature for one week. The condensation rate in the pipe had approached a steady value at the end of the week. The ratio of condensate collected from the 4 ft measuring section to the rest of the system was one to five and the computed k factor value was 3.432 Btu/hr(sq ft)(°F/in).

When the water table was raised so that free water covered the conduit, the condensate ratio of the measuring section and system was two to one, and the heat capacity of the boiler was not large enough to maintain 350°F steam temperature. Caulking of all possible sources of water leakage around the ends of the conduit and the thermocouples embedded in the Wicor did not materially lessen the rate of steam condensation.

Inspection of the conduit showed cracks in the Wicor radiating from the thermocouple wires and revealed lack of homogeneity in the material. Because it could not be established whether or not the thermocouple leads

were responsible for the cracking and because the air space created around the pipe by the corrugated paper had been sealed at both ends in the first specimen it was agreed that a second conduit would be poured for test.

The second specimen projects through the test box at both ends so a water tight seal between the end of the conduit and the wooden box is unnecessary and the air space adjacent to the pipe can be left open at both ends. Fewer thermocouples were used so none of them penetrate the entire Wicor envelope. The Wicor was mixed in a mortar mixer as recommended by the manufacturer instead of the cement mixer used for the first specimen. The curing period has been completed on the second specimen and a condensation test will commence May 31.

The 8x8x1 inch slabs cast when the first specimen was poured had a density of 67.3 lbs/ft³, oven dried at 215F. At a mean temperature of 129.6F the thermal conductivity was 1.925 Btu/hr (sq ft)(°F/inch). This value conforms to the curve of thermal conductivity of concrete at the same density made with various lightweight aggregates. The slabs were then mantained at a temperature of 350°F for 24 hours after which the thermal conductivity was 1.86 Btu/hr (sq ft)(°F/in.) for the same mean temperature. The heat transmission factor from the pipe surface to the surface of the conduit computed from data obtained at steady conditions in the moist earth was 3.432 Btu/hr (sq ft)(°F/in.) based on the temperature difference between pipe surface and a station six inches from the pipe surface just inside the surface of the Wicor.

Durant Insulated Pipe

Durant Insulated Pipe conduit is manufactured by the Durant International Corporation of Williamtown, N. J. The specimens submitted consisted of 20 ft lengths of four inch diameter black steel pipe encased in a two-inch thickness of Unibestos molded insulation. Load bearing spacer rings one inch in depth were placed around the insulation and a 26 guage galvanized sheet metal jacket was applied over the rings. The one inch void between insulation and jacket was filled by pouring high-melting point asphalt at a temperature of 450F through holes,

spaced 15 inches apart, in the metal jacket. The ends of these specimens were sealed by watertight welded end caps.

One of the three specimens did not have asphalt in the void between the insulation and the metal jacket as received. This void was filled in small increments with asphalt at temperatures of 350F, 400F, 450F and 500F in ambients of 75F and 12F to study the pouring characteristics of the asphalt.

Molded specimens of asphalt were heated in an oven over a range of temperatures to determine softening and slump.

A chromatographic Analysis of the asphalt was made in accordance with the method described in NBS RP 2577 "A Chromatographic Method for the Fractionation of Asphalt Into Distinctive Groups of Components."

Several test conditions were created to determine whether the Unibestos insulation could be dried out if it became wetted during installation and what happened to the asphalt jacket when saturated steam at a temperature of 375F was passing through the pipe (1) with the metal jacket removed and the conduit buried in the ground, (2) with the metal jacket removed, the insulation saturated with water, and the conduit buried in the ground, (3) with the metal jacket removed, the insulation saturated with water, and the conduit suspended above ground, (4) with the metal jacket in place, the insulation saturated with water, and the conduit suspended above ground.

Conclusions

1. When installed under dry conditions, temperatures on Unibestos and asphalt were very close to those advertised by the manufacturer.

2. There was a slight tendency toward plastic flow of the asphalt in the dry specimen when buried. This was a little more pronounced at the ends near the metal cap and at the spacer rings.

3. When saturated with water the Unibestos will absorb a maximum of 10 to 12 lbs per running foot on a 4-inch pipe.

4. When installed in the ground with wet Unibestos and tightly sealed, the steam formed in the insulation ruptured the asphalt covering.

5. With a steam temperature of 375F in the pipe the Unibestos dried approximately one half its thickness in two weeks when buried.

6. About two-thirds the original quantity of water absorbed by the Unibestos was evaporated from the buried test specimen in two weeks. There was evidence that the moisture distribution had approached a steady state during this time.

7. The outer half of the Unibestos covering was obviously wet, whereas the inner 3/4 to 1-inch was apparently dry. There were pockets of free water in the inside surface of the asphalt covering at the end of two weeks.

8. The temperatures on the inner and outer surfaces of the asphalt reached 211 to 216F at some stations during the first hour after admitting steam to the pipe. After two weeks operation the temperatures ranged from 135F to 198F. The maximum temperature observed in the dry specimen was 139F.

9. The asphalt on the wet specimen became quite soft and there was some plastic flow of the asphalt away from the top side, especially near the metal caps.

10. When the Unibestos was wetted and the specimen mounted above ground without the metal cover, and steam admitted to the pipe at increasing temperatures from 275 to 345F during an eight hour period, the asphalt envelope softened and fell off leaving a thin asphalt film on the Unibestos. After 10 days heating with steam at 373F the Unibestos was dry from the pipe surface outward for about one half its thickness; the remainder was quite wet to the touch.

11. When the Unibestos was wetted and the specimen mounted above ground with the metal cover on, but the ends

of the insulating jacket open, steam at 373°F failed to distort the asphalt and dried the Unibestos for only 1/3 of its thickness. A column of water vapor was ejected when the asphalt was ruptured for inspection at the end of the test.

12. Molded specimens of the asphalt were subjected to controlled heating to determine softening and slump. The asphalt slumped some at 200F in two hours; it flowed outward into a smooth mass at 240F in 35 minutes.

13. The asphalt furnished by the manufacturer produced a good envelope without voids or seams when poured at temperatures of 350F, 400F, 450F, and 500F into pipe specimens at 70F and 12F.

Gilsulation

For underground studies of the heat transmission factor of Gilsulation with controlled conditions, the insulation was poured into a 12 1/2 by 12 1/2 inch form surrounding a four-inch pipe centered in a box 4'x4'x12' in size and filled with oven-dried dirt. After maintaining a saturated steam temperature of 350°F in the pipe for about two weeks a steady rate of heat loss was observed and the temperature gradient through the Gilsulate and surrounding earth was steady. The steam was then shut off and the installation allowed to cool after which the earth was saturated by introducing water at the bottom.

Observations were made of heat loss and temperature distribution at steady conditions with steam at a temperature of 350°F in the pipe when the water table was one foot below the center line of the pipe, at the center line of the pipe, and one foot above thecenter line of the pipe.

A 20 foot section of four inch pipe was installed in a trench about 13 inches wide and 16 inches deep. Wet Gilsulation and dry Gilsulation was placed around the pipe during two successive tests to a minimum thickness of four inches and covered with six inches of dirt. The insulation was heated as rapidly as the steam generating