Coal tar study valid for typical shingle-style BUR

This report is the third part of a three-phase program to study the relationship between temperature-viscosity and interply weights achieved during mopping and mechanical application of hot coal tar roofing membranes. The test procedures used during the first two phases involved the ply-on-ply application of the tarred felts. This method was based upon the procedures described in NBS BSS 92, "The Viscosities of Roofing Asphalts at Application Temperatures" (December 1978).

Phase III was conducted to develop a correlation between the ply-on-ply technique and the shingle method of built-up roofing application.

Four test roof sections were constructed using a mechanical spreader and four test roof sections were mopped.

A total of 43 coupons, each measuring 16 inches by 9 inches (1 square foot), were taken. Eight additional coupons were forwarded to NRCA.

The examination of these coupons included calculating interply quantities of coal tar materials.

Objective

The objective of Phase III was to determine if a correlation exists between the amounts of interply coal tar products applied during a shingle-fashion installation and the amounts applied during a ply-on-ply installation using both mechanical and mopping procedures.

Study parameters

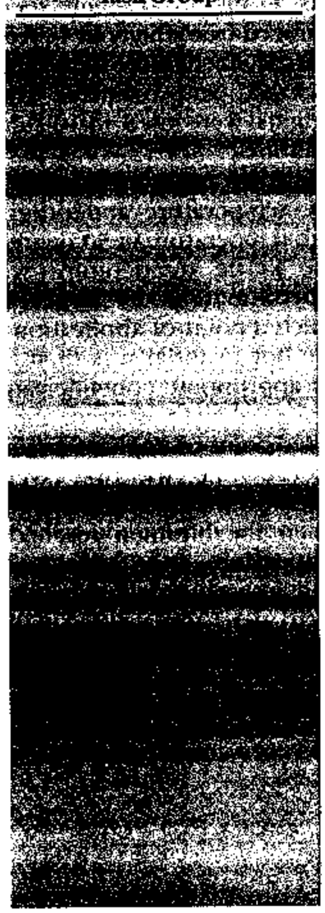
Three important variables affect the interply mopping weights of hot-applied coal tar roofing products. They are:

- the physical and rheological properties of the materials;
- the point-of-application temperature; and
- the method of application.

The Task Group consisted of Koppers representatives George Adomshick, Donald Waltz Jr. and James Weideman, and NRCA representatives William Cullen, Robert LaCosse and Marlin Potteiger.

Established EVT can be used, say researchers

Report prepared jointly by representatives of The Koppers Co. and NRCA's Task Group



It is recognized that several factors occur at the jobsite that influence the amount of coal tar actually used in addition to the variables that affect the amount used for interply application. However, a study of these factors and their contribution to the total amount of coal tar used was not a part of this study.

Variety of factors tested

Materials—two coal tar products were included in the study: coal tar roofing pitch, ASTM D-450 Type I, and coal tar bitumen, ASTM D-450 Type III. Type I is the traditional coal tar pitch in use for decades, while Type III's formulation has been modified for low fume evolution to improve environmental and working conditions during application. The materials used were taken from stock inventory and are representative of those available in the market.

Temperature—tests were conducted at three application temperatures: 300F, 350F and 400F.

Application methods—built-up roof membranes were constructed using two methods: by mechanical spreader and by direct mopping application. The felt was rolled in manually and broomed in for both methods. The felts were installed shingle fashion, with each sheet offset approximately 8 1/2 inches from the previous sheet. This simulates the procedure used in the field for constructng a four-ply built-up roof membrane.

Site—the tests were conducted in Building 37 at Verona, Pa., an auxiliary unit of Koppers Science & Technology Center, Monroeville, Pa., near Pittsburgh. The test site is an enclosed area capable of maintaining inside air temperature between 60F and 80F.

Test equipment

Kettle—a 125-gallon kettle was selected for its ability to supply adequate quantities of bitumen for each test. It was capable of raising and maintaining bitumen to preselected temperatures, and it was convenient to maneuver and empty when changing from one type of material to the other.

Mechanical spreader—one mechanical spreader, corresponding with Unit A as described in Phase II, was used. This unit was a hot dispenser without felt layer. It was 36 inches wide, of steel construction, with a hand-controlled flow and a 36-inch brass chain mop. It weighed 120 pounds.

Mopping equipment—mopping equipment corresponded to that described in Phase I. The aluminum mop handle was 10 feet long. A 2½-pound, single-ply cotton mop head was used. The mop cart was a round insulated steel unit.

Broom—the broom used was a spring-metal type, measuring 35 inches wide.

Template for cutting coupons—to obtain the coupons, a 16-inch-by-9-inch (1-square-foot), flat, steel template with handle was positioned flat on the membrane such that all four plies plus the head lap of the shingle-fashion construction would be included within the specimen. The coupon was carefully cut to the template shape with utility knives.

Scale—a Metler 15,000-gram balance with 2-decimal accuracy was used to weigh the samples.

Test surface—the deck was 22-gauge steel with a 2½-inch-wide flute on wood framing. Flake board 15/32 inches thick was laid over the steel decking and nailed to the wood framing through the steel ribs. No. 15 coal tar-saturated felt was rolled out and stapled at each end to serve as a separator sheet. Each test section was approximately 6 feet wide. Test sections constructed by hand-mopping were 18 feet long. Those constructed using mechanical spreaders were 50 feet long.

Roofing personnel—the roofing crew, which consisted of a spreader operator, roll man and kettle operator, is employed by Pennsylvania Roofing Systems, Inc., a contractor member of NRCA. Crew members were experienced in mechanically spreading and mopping built-up felts and coal tar products. They are members of the United Union of Roofers, Waterproofers and Allied Workers Association, Local No. 37 (AFL-CIO).

FIGURE 1 Test Coupon Placement—Hand-Mopped Samples

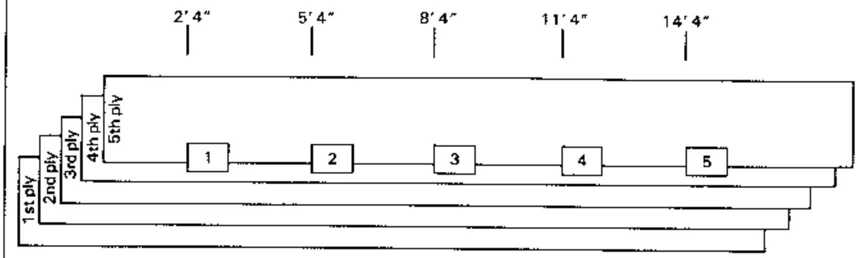
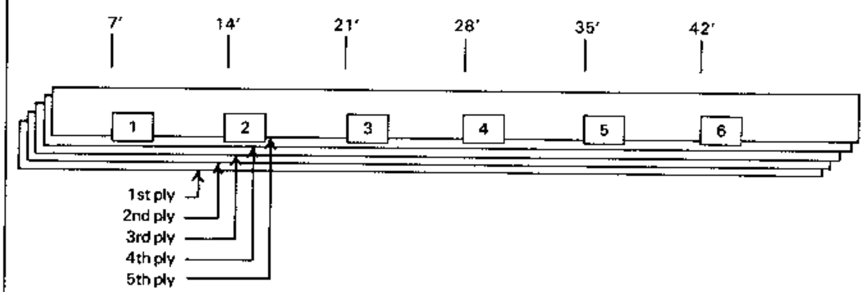


FIGURE 2 Test Coupon Placement—Mechanical Spreader Samples



Test procedures

Twenty rolls of tarred felt were prepared by discarding the first 10 feet of each roll. Ten 12-inch-by-12-inch specimens were removed from the next 15 feet of each roll. The specimens were then weighed, labeled, packaged and retained. The actual felt weights were used in calculating interply quantities.

The test applications were started at the low temperature and progressed to the high temperature in 50-degree increments. The kettle temperature was raised to approximately 25 degrees above the selected point-of-application temperature. The hot material was then transferred to the appropriate container and allowed to cool to about 5 degrees above the preselected point-of-application temperature.

Meanwhile, the first layer of felt was rolled on the deck and stapled into place. When the bitumen reached the desired temperature, four additional plies of felt with interply applications of bitumen or pitch were applied. Each ply was offset approximately 8½ inches from the previous ply to simulate shingle-fashion constructions.

The materials used were taken from stock inventory and are representative of those available in the market.

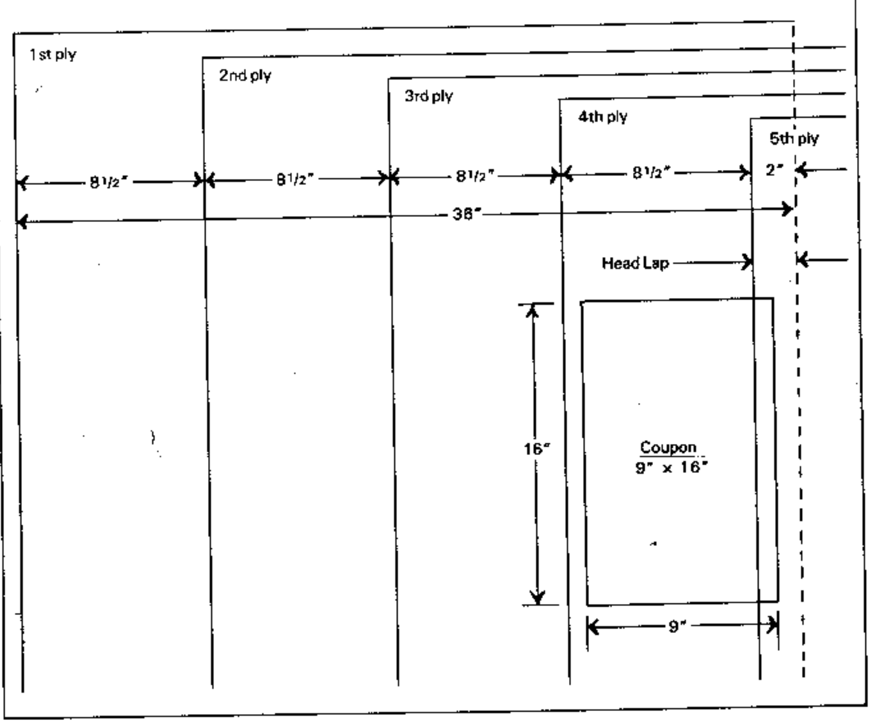
A similar series of tests is being considered using asphalt and glass, and organic-based felts.

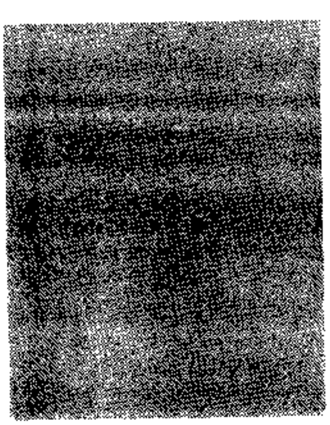
When the membrane cooled, coupons were cut from it at preselected locations, labeled and weighed. Figures 1 and 2 identify the location of the various coupons taken. These coupons were packaged and retained for laboratory evaluation. The average interply quantity in pounds per square feet per ply was calculated by subtracting the actual felt weight in the coupon from the total coupon weight. Figure 3 illustrates the placement of the 9-inch-by-16-inch template.

Test results

Application rates of interply material—Table 1 gives the interply weights of bitumen and pitch for each of the 43 coupons. The weights are expressed in pounds per 100 square feet per ply. A general correlation exists between the interply application weight and the point-of-application temperature, with larger quantities of the coal tar products being applied as the point-of-application temperature decreased. However, there was not a straight line relationship between the average interply quantity and the point-of-application temperature.

FIGURE 3 Template Placement





Application temperatures of 300F to 400F resulted in average interply weights ranging from 17.4 to 44 pounds per 100 square feet per ply. The quantities varied with material, temperature and application method used. Table 1 shows the average interply mopping weight for each test section and the average of all coupons.

Table 2 compares the average interply weights at corresponding point-of-application temperatures obtained from Phase III tests to those obtained from Phases I and II.

There appears to be a good correlation of interply weights to temperature at the higher point-of-application temperature range. For example, at 350F, the coal tar bitumen interply mopping weights for Phase I and Phase III were 23.1 pounds per square and 22.2 pounds per square respectively. At 400F, the interply application weights for Phase II and Phase III were 22.9 pounds per square and 25.1 pounds per square. However, there was a lack of correlation at the low end point-of-application temperature of 300F. A good correlation was also observed for pitch application at 400F.

Summary and conclusion

On an overall basis there was an excellent correlation between ply-on-ply and shingle-fashion application techniques for both coal tar products, considering the limited program that was conducted.

The conclusions drawn from Phase I and Phase II can thus be considered valid. Briefly stated, they are as follows:

- The application of coal tar bitumen and pitch should be in a viscosity range of 15 to 40 centipoise (12 to 32 centistokes).
- The suggested EVT for both Type I and Type III coal tar products is that temperature at which the viscosity of the material is 25 centipoise (approximately 20 centistokes).
- For the specific coal tar products used in this study the EVT is 375F ±25 degrees for coal tar bitumen (Type III) and 360F ±25 degrees for coal tar pitch (Type I).
- For the coal tar products used in this study, point-of-application temperatures between 335F and 400F appear to be appropriate for both mechanical spreader and mopping application techniques.

In general, the lower the point-of-application temperature, the greater the quantity of interply material applied.

TABLE 1: Coal Tar Bitumen/Coal Tar Organic Felt Interply Weights: 4 Plies—3 Interply Applications

test no.	B1	B2	B3	B4	B5	B6	P7	P8
temperature at point of application (°F)	300	300	350	350	400	400	400	400
method (2)	M	S	M	S	M	S	S	M
interply #/100 ft.²								
Cut # 1	28.0	47.6	20.1	24.2	17.1	20.9	22.5	19.0
2	28.6	46.6	24.5	30.8	18.1	24.2	24.3	18.7
3	23.9	43.9	19.1	30.2	17.6	27.4	21.1	17.7
4	24.2	45.9	22.1	24.0	16.2	28.4	23.1	14.3
5	22.7	38.9	20.3	25.4	—	21.1	20.5	22.1
6	—	40.8	—	30.0	—	28.7	22.9	—
Average	25.5	44.0	21.2	27.4	17.3	25.1	22.4	18.4
Standard Deviation	2.6	3.5	2.1	3.2	0.8	3.6	1.4	2.8
Variance	7.0	11.9	4.5	10.4	0.7	12.7	1.9	7.9

(1) B —Coal Tar Bitumen
P —Coal Tar Pitch

(2) M—Mopped
S —Mechanical Spreader

TABLE 2—Comparison of Interply Applied Weight Per Square of Phase III to Phase I and Phase II

		coal tar bitumen temperature			coal tar pitch temperature
Phase #	Application Method	300 F	350 F	400 F	400 F
I	hand-mopped	34.5	23.1	21.3	17.5
III	hand-mopped	25.5	21.2	17.3	18.4
II	mechanical spreader	29.6	23.0	22.9	21.5
III	mechanical spreader	44.0	27.4	25.1	22.4

There was an excellent correlation between ply-on-ply and shingle-fashion application techniques for both coal tar products.

A summary report is being prepared comparing the results from all three phases of this program along with recommendations for implementing the findings of the program into realistic construction practices.

A similar series of tests is being considered, to study the relationship between application temperature, viscosity and interply mopping weights using asphalt and glass, and organic-based felts.

Acknowledgments

There were many people who helped in the various phases of this project and we thank them all.

Special acknowledgements should be made to:

Koppers Laboratory Evaluations:
David Kennedy
Richard Nagy
Roofing Contractor:
Pennsylvania Roofing Systems, Inc.
Frank Funovits Jr., co-owner
Roofing Crew:
James Ashton
Robert Zengreth
Eric Zengreth
(All are members of Local No. 37 [AFL-CIO] of the United Union of Roofers, Waterproofers and Allied Workers Association.)

REFERENCES

[1] Coal tar pitch refers to ASTM D-450 Type I and coal tar bitumen refers to ASTM D-450 Type III. ASTM Standards, Section 4, Volume 4.04.

[2] "Phase I: Program to Sutdy the Relationship Between Temperature-Viscosity and Interply Weight During Mopping Application of Roofing Membranes Using Hot-Applied Coal Tar Products," *Roofing Spec* April 1985, pp. 35-42.

[3] "Phase II: Program to Study the Relationship Between Temperature-Viscosity and Interply Weight During Mechanical Spreader Application of Roofing Membrane Using Hot-Applied Coal Tar Products," *Roofing Spec*, February 1986, pp. 41-49.