

MEMORANDUM

PLAINTIFF'S EXHIBIT

In Reply to B Memo
8/29/75 Date 9/15/75 From BBH To B- Mr. Heim
Subject HORIZONTAL CRACKING

BIR-332

INTRODUCTION & SUMMARY

At the present time, although there is more understanding of the nature and scope of the cracking problem than there was a year ago, there is no recommendation for a positive cure for the problem. We know that this type of cracking does not occur on a shingle that is not sealed down. The experience encountered in trying to eliminate the self-sealing feature from the Architect 70 proves that the most obvious remedy cannot be used. The public has been convinced that the self-sealing feature makes a superior product.

Attempts to find means of reducing the susceptibility to cracking while maintaining the seal-down feature have not yet been productive, primarily because of the inability so far to produce horizontal cracking on the machines designed for this purpose. Despite experimenting with varying cycles, there is apparently some condition or combination of conditions encountered in actual service which has not been incorporated into the test cycle. Work is being continued to overcome these shortcomings.

Outdoor exposures on house roofs in Florida have been made starting in 1973 and continuing through early 1975. These include standard Mark 25 shingles and several variations incorporating features which may help improve resistance to cracking. Initial cracking in the control shingles may occur within the next several months, and an inspection is planned to check this out. Duplicates of these shingles are on Shreveport test decks, but experience has shown that cracking has not occurred in the past as quickly on the Shreveport decks as on actual houses. Therefore,

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early information is not expected from these test deck exposures.

CURRENT EXTENT OF CRACKING PROBLEM

Attached to this report is a summary obtained from BBQ of the extent of cracking complaints experienced since 1972. It is important to note that this problem is not confined to no cut-out shingles. It is confined to self-sealing shingles, but Wind Seal shingles are as susceptible as Jets. Mark 25 shingles are the most numerous and costly source of complaints. This is especially dramatic when the difference is considered between the number of squares sold of Mark 25 shingles and those of Wind Seals and Jets. In 1974 and to date in 1975, the number of cracking complaints on the Mark 25 shingles constitute 49% of those settled. Because of the longer guarantee and higher price the liability is proportionately much greater.

A study of the complaint summary leads to several additional conclusions:

1. The frequency at Charleston is continuing to increase, but the dollar value of all settlements in 1975 seems to be leveling off.
2. The frequency and dollar value of 1975 settlements at Shreveport is lower than 1974. However, Carl Futrell's replacements in Houston have almost no complaints settled in 1975, versus Futrell's record of 28% of all Shreveport complaints settled in 1974. Having seen roofs in Houston, BBQ and BBH are convinced that the problem has not ceased. The 1975 figure appears to be unrealistically low.

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3. In the Charleston division, Jim Saunders accounted for 40% of the 1974 cracking complaints and 25% of the 1975 complaints. The rest were divided among the other salesmen, with no salesman having as many as 10 complaints.
4. In the Shreveport division, Carl Futrell and "Red" Houston accounted for 53% of the 1974 cracking complaints. "Red" Houston is accounting for 28% of the complaints in 1975, but the Houston, Texas territory is producing almost no complaints, as explained above in Item #2.
5. Despite the fact that Orlando, Florida, Houston, Texas, and Baton Rouge, Louisiana are high volume sales areas for asphalt roofing, and in each case the climate unusually severe, it is fairly evident that the influence of the particular salesman in each territory is affecting the rate of complaint settlement. Statistically, it would appear that cracking is a relatively minor problem in other localities. Actual roof inspections and discussions with other salesmen and managers show that the horizontal cracking can and does happen anywhere in the country, despite the fact that only in the South is it of sufficient severity to give rise to a major volume of complaints.

PROGRAM FOR SOLUTION TO PROBLEM

Following the first awareness of cracking, in 1969, an investigation was started to determine the cause and extent of the problem. Personal inspections were conducted by Carroll Homan and Leonard Weaver from late 1971 through May, 1974. A consultant, Donald J. Smith, was employed to cover the entire eastern part of the United States from Florida and the Gulf States to New England.

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The following conclusions were reached:

1. Horizontal cracking is limited to seal-down shingles.
2. The severity is greatest where climatic conditions of heat and humidity are the most severe, i.e., the deep South.
3. The severity in a given location is greatest where the exposure to the sun is the most intense, e.g., dark color on the south side of the building, with a low slope roof.
4. Heavy weight shingles (280# and over) are most vulnerable, with cracking occurring in as little as 3-4 years after installation.
5. This phenomenon is not limited to Bird shingles, although in any given area, the cracking of Bird thick butt shingles appears to be more severe than competitive uniform thickness shingles of comparable age and weight.
6. Despite the lack of complaints in the Perth Amboy and Norwood divisions, cracking is not limited to the South. It has been observed in New England and the mid-Atlantic States, and complaints have been received from the old Chicago division (upper mid-West). However, the rate of cracking is apparently slow enough in the north to keep complaints to a minimum.

POSSIBLE CAUSES FOR CRACKING

Many theories have been advanced to try to explain the cracking phenomenon. Since it is limited to self-sealing shingles, it is apparent that there must be forces causing the shingle tab to contract as it weathers. The tab is physically held by both nails and adhesive along two parallel lines about 4-5 inches apart. When the contraction occurs, the forces are

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concentrated midway between the lines where the tab is held, until rupturing occurs.

Obviously variations between shingles cause these contraction forces to vary. The two elements in all shingles which are inclined to contract are, 1) the asphalt and 2) the felt. Since all seal-down shingles do not crack at the same rate, the task in minimizing cracking becomes a matter of identifying and controlling the critical variables.

POSSIBLE MEANS OF REDUCING CRACKING

Asphalt

The amount and type of asphalt are believed to play a part in cracking. Since heavy weight shingles have more coating asphalt, and since they do crack faster and more severely, it would appear that there is more than the optimum amount of coating present. It is known that, on aluminum panels, there is an ideal thickness of asphalt which gives the best crack resistance. Above and below this thickness, cracking occurs more rapidly. In thickness much above optimum, cracking is severe and deep. In the case of shingles, as opposed to aluminum panels, there are one or two layers of granules present. These interrupt the uniformity of film thickness of the asphalt and, to some extent, diminish the logic of the thin versus thick film analogy. However, experience does show that thick shingles deteriorate faster than more conventional ones. Therefore, cracking can be delayed by not making the shingles too thick.

Another variable in the case of asphalt is its own resistance to weathering depending on source, processing, etc. In the case of coating on aluminum

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panels, various asphalts show different rates of failure, with ratios as great as 5:1 in some instances. Failure is characterized by cracking which results from shrinkage of the asphalt. Here again, in the case of shingles, the presence of granules affects the failure rate. However, it could be that coating which shrinks and cracks most rapidly on aluminum panels would do the same on a shingle. Therefore, there is some reason to believe that cracking can be delayed through the use of the most durable coating available.

Felt

Cellulose felt is known to be an unstable product. When saturated and made into shingles, it exhibits many types of distortion on weathering. Depending on conditions, the shingle will curl, claw, fishmouth, shrink, and, in the case of many self-sealing shingles, crack horizontally.

Experience shows that many of these factors can be controlled. Proper saturation controls curling. Adequate back coating helps control fish-mouthing and clawing, although it has also been verified that other subtle variables affect clawing, such as the pH of the dry felt.

The mechanism of felt shrinkage is successive cycles of wetting and drying. Felt made on cylinder machines, being more directional than that made on a Fourdrinier machine, is more inclined to shrink in the cross direction. It is also weaker in this direction. It is a reasonable assumption that stabilizing and strengthening the felt could lead to a shingle more resistant to horizontal cracking. It is also believed that

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maximum saturation and ample back coating should minimize the adverse effects of successive cycles of wetting and drying.

RESULTS OF EXPERIMENTAL WORK TO DATE

Natural Weathering

So far, experimental work has consisted of exposing shingles from mill trials on actual roofs in the Orlando, Florida area, and attempting to duplicate the cracking phenomenon under accelerated conditions in the laboratory.

The following shingles are on roofs in Florida:

1. St. David's Episcopal Church
Lakeland, Florida
Applied January 26, 1975
48 squares of Sable Black Std. Mark 25 Shingles made at FB and
60 squares of experimental Mark 25 Shingles made at FB. The
experimental shingles contained 10% ground mica in the coating.
(In lab accelerated weathering tests, the mica greatly improves
the durability of coating asphalts.)
2. House of Wm. H. Crapps
Sanford, Florida
Applied July 17, 1974
260# Black Johns-Manville Class A glass mat shingle
3. House of Gerald Hooks
Orlando, Florida
Applied July 1, 1974
Mark 25 Shingles, Black. (For weathering comparison with J-M
260# glass shingles, above.)
4. House of E. L. Fulford
Sanford, Florida
Applied August 15, 1973
Fiberglass based Jet Shingles (White), run at FB

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5. House of Kelly Lake
Sanford, Florida

Applied June 16, 1973

Mark 25, Sable Black with the following variations-

- a. Std., with adhesive spots
- b. Std., except with no adhesive spots
- c. Std., except Wind Seal Adhesive spots in vertical bars instead of spots.
- d. Std., except saturation kept deliberately low (138-146%)
- e. Std., except low back coating (2.1-2.6#/100 sq. ft.)

Duplicate samples of the above-listed roofing have been exposed on the Shreveport test deck. Several of them were also exposed on the machines at BBH intended to produce cracking under laboratory conditions.

So far, there have been no definitive results anywhere. It is expected that some cracking may appear on the more susceptible of the older installations by next spring, and an inspection is being planned.

Artificial Testing

The results of experiments on the BBH artificial testers have been disappointing.

Following the development of some horizontal cracking on a prototype piece of equipment, six new machines were designed and built, with the intention of duplicating and improving upon the prototype. The improvements were in the direction of automatic controls to permit 24-hour operation. The machines were started up about a year ago.

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The first tests were complicated by the need for correcting unexpected mechanical and electrical equipment problems. Also, in an effort to accelerate the test conditions, initial settings were too severe and produced blistering and/or sealing of the entire tab by back coating instead of merely at the position of the adhesive dots. Hence, the samples were spoiled as candidates for horizontal cracking.

A new series of sample boards was started in early 1975. The cycles were controlled better to prevent blistering, and sheets of foil were placed between shingles in order to keep them from sticking where they weren't supposed to.

By June, some cracking had begun. It was more or less random, but it was anticipated that horizontal cracking would soon follow. This has not happened yet, nor has the original cracking progressed much. Therefore, it seems necessary to start up a new series of sample boards, after analysis of the reasons of the failure of the series just completed, and their elimination, if possible.

Why Didn't The Accelerated Decks Produce the Desired Results?

The intent of the decks was to duplicate conditions which product horizontal cracking in actual service:

1. Degradation of the coating asphalt by UV radiation and heat.
2. Thermal shock by cold water to the shingle (as produced by frequent thunder showers in Florida), calculated to induce cracking in the asphalt embrittled by UV and heat.
3. Moisture from the water used for cooling producing humidity conditions prevalent in the South.

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In analyzing these conditions, it appears that the UV radiation, heat, and thermal shock were produced as desired. However, the horizontal cracking did not develop. It appears that the cycles used may have produced too much moisture. As a result, the shingle felt became wet. Instead of going through cycles of drying and shrinking, as it does in Florida between showers, it was subjected to another chilling cycle, during which time its moisture was replenished.

These moisture cycles varied from intervals of 2 hours to 15 hours. Even the 15-hour gap between wetting cycles did not permit the felt to dry. (Laboratory fishmouth tests have conclusively shown that a minimum of a week of uninterrupted heating for 24 hours per day is required to dry the felt enough to produce fishmouthing.)

In previous attempts to analyze the factors at work in horizontal cracking, this particular one has never been defined with enough precision to cause alterations of the cycles of the test equipment. However, the present set of decks, during the month of September, is being subjected to alternate weeks with light and heat only but no water. It may be that it is too late on these particular shingles to produce horizontal cracking. If nothing happens by the end of September, it is planned to discontinue these shingles and begin again with new decks.

SUGGESTED CONTINUED PROGRAM

It is proposed to:

1. Continue to follow the outdoor decks in Florida, with additional exposures of other products where appropriate.

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2. Make periodic inspections of Shreveport test decks.
3. Continue work on accelerated decks at BBH, with cycle variations, such as more thorough drying to permit felt shrinkage.
4. Make lab studies on shrinkage properties of felt (dry, saturated, saturated and coated, etc.), apart from the artificial decks to measure amount of shrinkage from alternate cycles of wetting and drying, to see if means can be determined to minimize the dimensional changes and strengthen the felt to reduce its susceptibility to cracking.
5. Continue to check the possible advantages of glass mat shingles with respect to resistance to cracking.

CONCLUSION

Since the Mark 25 Shingle is the principal cause for complaints in the South, it would seem logical to drop the product, at least there. However, it seems that this cannot be done completely, since buildings are being specified to use this product exclusively.

Based on the preceding rationale, but lacking proof, there is a chance that the crack resistance of the Mark 25 will be improved by two steps. One is to make it of uniform thickness, and the other to make it on heavier felt. The first step is to reduce the weight of the exposed butt without reducing the overall product weight. The second step is to reduce the thickness of coating asphalt and to give a little stronger felt for better resistance to pulling apart.

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These steps may not work, but there is a statistical probability that they should give a few extra years of crack-free performance on the Mark 25.

LHWeaver/rp
Attach.

HORIZONTAL CRACKING COMPLAINTS

	<u>Southeastern Div. Charleston FK</u>		<u>Southwestern Div. Shreveport FS</u>	
	<u>No.</u>	<u>Cost</u>	<u>No.</u>	<u>Cost</u>
1972	27	\$12,749.23	12	\$ 2,313.98
1973	45	26,131.95	20	4,379.25
1974	98	65,986.57	90	32,752.92
1975 (1st. 7 mos.)	74	37,999.21	47	21,177.22

FS - 1974

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<u>Salesman</u>	<u>No. of Complaints</u>
C. C. Futrell	26
L. G. Houston	23
C. C. Pregge	3
E. P. Hennessey	2
R. A. Sheffield	8
W. J. Swain	6
W. C. Ingram	3
B. J. Langley	1
A. R. Sawyer	3
J. E. Evans	2
D. J. Schanz	2
J. W. Cope	3
G. G. Tims	1
H. J. Drasutis	2
J. R. Nugent	1
D. J. Lankford	1
J. H. Studdard	2
D. C. Fischer	1

FK - 1974

W. W. Mason	5
J. E. Saunders	38
J. Nelson	3
D. Regan	5
R. A. Scott	5
A. D. Gallaher	3
E. F. Smith	4
J. A. Scull	7
J. Burn	3
C. Ford	2
P. Steele	2
D. S. Clarke	2
J. R. Bellmyer	1
C. D. Harding	3
W. J. Mullins	2
V. Nelson	9
J. M. Dunn	1

FS - 1975 (1st 7 mos.)

HORIZONTAL CRACKING COMPLAINTS

<u>Salesman</u>	<u>No. of Complaints</u>
B. L. Pevey	1
F. C. Dietrich	1
J. E. Evans	4
L. G. Houston	17
J. W. Morriss	2
C.C. Pregge	1
D. J. Schanz	4
G. G. Tims	2
J. S. Moll	2
H. W. Williamson	1
C. C. Futrell	1
R. A. Sheffield	3
H. J. Drasutis	1
A. R. Sawyer	1
H. B. Bauchamp	2
J. W. Cope	2
E. P. Hennessey	2

FK - 1975 (1st 7 mos.)

C. D. Harding	5
W. W. Mason	3
J. E. Saunders	28
J. H. Burn	5
R. A. Scott	2
J. A. Scull	4
C. L. Ford	6
D. S. Clarke	5
P. Steele	1
J. Nelson	8
J. Dunn	1
A. Gallaher	2
W. Mullins	1

No. of Complaints

<u>Type of Shingle</u>	<u>1974</u>		<u>1975 - (1st 7 mos.)</u>	
	<u>FK</u>	<u>FS</u>	<u>FK</u>	<u>FS</u>
Mark 25	51	38	33	26
Wind Seal Jet	16	22	11	11
Wind Seal	19	26	18	7
Seal King	2	3	1	2
Firescreen	3	1	6	1
Master-Bilt	5	-	3	-