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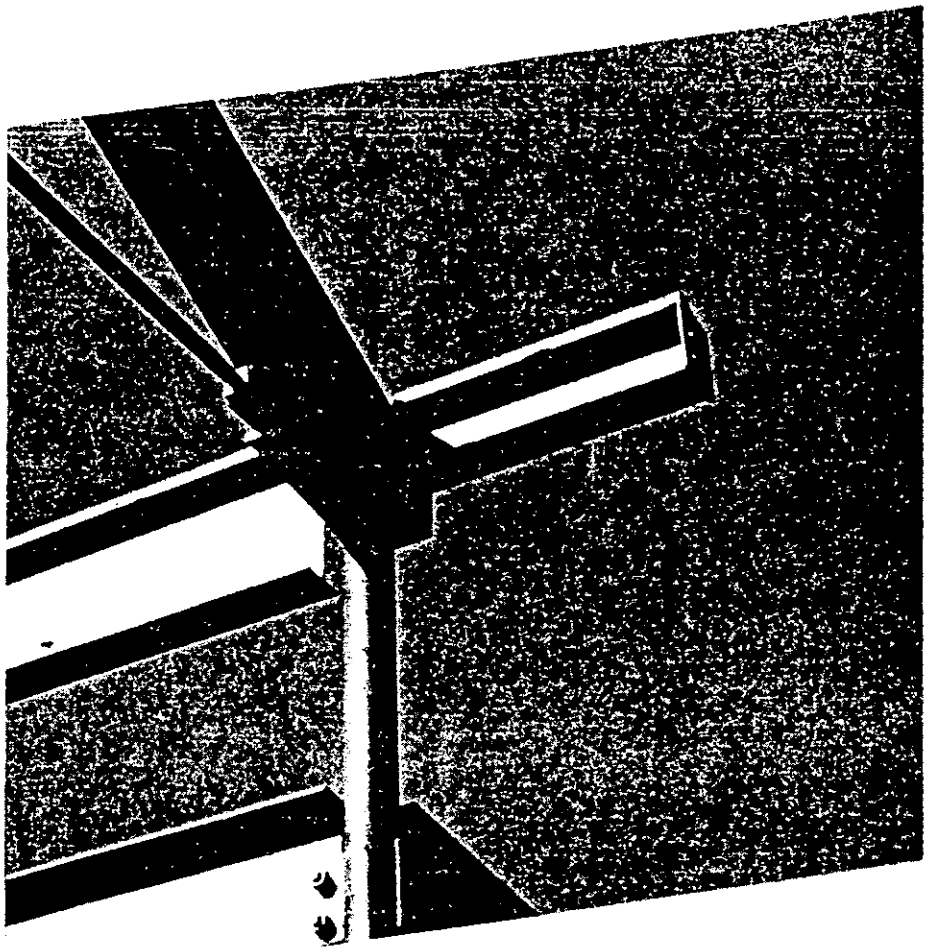
An Investigation of Premature Roof Failures in Florida



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AN INVESTIGATION OF PREMATURE ROOF FAILURES IN FLORIDA

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DESCRIPTION OF ACTIVITIES

Roof failures, at an early age, are a problem in Florida. Although there is a vast amount of evidence to support this, until this research began there has been a very limited amount of written data available to bring the various aspects of investigating and solving of these problems to a viable conclusion. This is not unique to the State of Florida.

The National Roofing Contractors Association (NRCA) began a study called Project Pinpoint in 1974 to locate roof failures around the nation. The results of Project Pinpoint are published to show the percentage of each of 8 different types of failure by state. A printout of this study in November of 1981 shows that in 1976, 1.2% of splitting failures and 1.2% of ridging failures occurred in Florida. The study goes on to say that only in 1977 were enough forms received to consider the results statistically valid. (Exhibit 1)

In Florida there is a very active Florida Roofing, Sheet Metal & Air Conditioning Contractors Association (FRSA) but this group does not keep records of roof failures. Meetings with the technical committee of FRSA and interviews with individual members indicate that there are indeed many and varied roof failures throughout the state.

In gathering material for this report, trips were made to a number of places in Florida and one place out of the state. The first trip, out of the state, was to attend the "Built-Up Roofs Institute" in Madison, Wisconsin. This was a 2-day cram course in the latest materials and

methods of building built-up roofs. In Florida, a trip was made to Orlando to attend an FRSA convention and meet the people doing the roofing work. At this time there was also an opportunity to look at the latest material and equipment and also to attend a number of workshops, including one on fiber glass felts. In August and again in October, trips were made to Orlando to attend meetings of the Technical Committee of the FRSA. At these meetings, the help of this group was enlisted in tracking down the causes of roof failures. In September, a trip was made to Tallahassee to interview Bob Dove of Dove Roofing Co., Inc. and to study his library of roofing materials. Also in September, a call was made at the HUD office in Jacksonville to request that they notify the investigation of roofing problems related to their property management. This trip was repeated in December and by telephone conference, several of the county HUD offices were interviewed for their roofing problems. In October a trip was made to Orlando, where in company with several FRCA members trips were made to locations where roofs were in the process of being applied. These trips were to investigate the part that application and quality control play in roofing performance. Also, in October a trip was made to Tampa to visit Jim Walters Research Lab and to observe the work going on there.

By these meetings and interviews it became obvious that the problems of roofing failures were manifold and varied. Since this research was limited in scope and the subject, "Premature Roof Failures in Florida," is so broad, it was deemed necessary to focus at this time on one part of the problem. The part chosen was built-up roofing.

FINDINGS

Asphalt is one of the older methods of waterproofing things, having been used by Moses' mother to waterproof the basket in which he was placed to float in the river. In a paper titled, "Roofing Practice in the USA: Technique or Technology?" published in 1977, Robert E. Linck said, "Consider that of 307 roofing materials for which patents had been issued by 1875, only one, the conventional built-up roof with slag surface, has remained in continuous use."[1] Built-up roofing has continued to keep up with the times in that new ideas have been incorporated into it as they became available. Built-up roofing consists essentially of a reinforcing material, a waterproofing material and a protective coating to ward off damage from ultra-violet rays and from traffic. Materials that have been used for the reinforcing include rag felts, fiber felts, asbestos felts, glass felts and for specialized application, polyester felts. The most common waterproofing agents are asphalt and coal tar. Protective coatings are usually stone, slag or lightweight aggregate and specially prepared cap sheets coated with fine granules.

Glass fiber felts are one of the newer materials that are in very wide usage, but which are reported by many roofers to be the cause of several problems.

The FRSA has conducted two surveys of users of fiber glass felts among its members and sizeable numbers of the respondents indicated some trouble with the material. The first survey conducted in November of 1980 showed 33% having some trouble and the second survey conducted in

July of 1981, indicated that 27% were still having trouble of some sort when using asphalt felt. (See Appendix 2)

Fiber glass felts are manufactured by first making a mat of glass fibers, then impregnating that mat with asphalt. The glass fibers are either chopped or continuous - the latter is more common - and they are screened from a water solution, then sized to form the mat. This mat is then saturated with asphalt, but in such a manner that it is still porous. The mopping of the felt into the roof structure with hot asphalt is designed to penetrate and coat this felt in such a way as to make the entire built-up roof waterproof. This is a difference from the older felts which are in themselves waterproof, and goes against the trend in the rest of the construction industry to do more work in the factory and less in the field, i.e., ready hung doors, precast concrete, etc.

Quite possibly the reason the trend is this way in the roofing industry may have something to do with coated felts which were on the market for about 3 years in the early 1960's and have since been withdrawn from production. These materials were an effort to apply most of the asphalt in the factory so that only a minimal amount was added in the field to hold the layers together. It came on the market with great fanfare and apparently very little field experience. A number of things contributed to the failure of this type of system, including:

1. The water used in the manufacture of the felts was sometimes sealed in by the coating asphalt, later causing blistering.
2. The expense of the material caused manuafacturers to suggest the use of two plies rather than the 4 or 5 plies in a field

applied roof, making it more vulnerable to imperfect workmanship.

3. The material had a tendency to ridge and split.
4. Proper bonding of the plies was very difficult to achieve in the field with standard equipment.

The net result of the above was that the coated felts were withdrawn from production. At their last meeting, the ASTM cancelled the specification for the 43 lb. coated felt used in these roofs since the item is no longer manufactured.

Premature roofing failures are not unique to Florida, although Florida may have some unique causes for failure. C. Mattingly, an English roofing consultant, points out that there are many early roof failures in England and blames them on ".... introduction of new technology without adequate product development or proof of performance."[2] Built-up roofing in England has failed with such regularity that there has been a resurgence of interest in sloping roofs.[3]

There are similarities between England and Florida, in that both have very high humidity and both are subject to high winds. In England, an effort is made to control the moisture content of the felts that go into waterproof material.[4] Wrapping is useful only in keeping out moisture gain caused by problems of humidity and exposure; it could actually complicate problems caused by retention of moisture used in the manufacture of the felt. Future studies are planned

to determine the cost/benefit value of this packaging procedure.

The concern with moisture content in roofing felts is due to the fact that moisture in felt of as little as 3% can cause considerable loss of tensile strength.[5] Since tensile strength is the main reason for using felt in the built-up roof, this is serious. Also, it has been determined that roofing felts stored under conditions of high humidity (90% RH) can achieve a 3% moisture content. Further, when these felts are laid in hot asphalt, although there is some "boiling out" of the moisture, some of it is built into the roof in the form of blisters.[6] Blisters in built-up roofs do not go away of their own accord. When the roof gets hot, which would tend to soften the asphalt at the blister point, the vapor in the blister expands and thus makes the blister larger. When the roof cools, so that the vapor contracts, there is nothing to cause the asphalt to soften, thus blisters tend to get larger and larger.

Insulation as part of the roofing structure has come into fairly wide use since World War II. At the present time, approximately 75% of all roofs are built with insulation under the built-up membrane.[7] Due to high temperatures in Florida, insulation is probably even more widely used here than in other parts of the nation. Since the insulation prevents the heat from entering the building, it holds the heat in the roof structure and this tends to drive up the temperature of the roof surface. C. W. Griffin, Professional Engineer of Denville, New Jersey, wrote in a 1977 paper entitled "Impact of Roof Insulation on Life Cycle Costing of Built-Up Roof Systems" that:

"Thickened, more termally resistant insulation exposes a built-up membrane to several specific life-shortening effects. Roofing experts have cited the following:

Accelerated chemical degradation of bitumen.
Increased splitting hazard.
Reduced impact resistance.
Increased risk of slippage."[8]

For economic and comfort reasons, insulation will not go away. It is anticipated that the future will see more, not less, demand for insulation on roofs.

In 1976, future roof insulation problems were anticipated by Eugene R. McCormick, a Chicago area roofing consultant. The problem, which has become a reality, is that architects are specifying more insulation in terms of K or U factors, but they are not specifying how the insulation should be installed.[9] Because of labor cost factors, contractors have used thicker single layers of insulation instead of multiple layers, and this causes ridging which can destroy a roof at an early age.

Insulation on roofs is another area where technology is sometimes ahead of good practice. The best material in the world used in the wrong place is no longer the best material and, in fact, may be among the worst. Some of the expanded polystyrene and polyurethene materials were rushed into the roofing market before all the problems were solved. The main problem was that the insulation tends to melt at 200 degrees Fahrenheit, whereas the bitumen must be applied at approximately 400 degrees. The problem has been overcome, and now sandwich panels of these materials are being successfully used as roof insulation.

In hot areas of Soviet Central Asia, efforts have been made to cool built-up roofs with water, according to a paper presented by three Russian engineers in Brighton, England in 1974. Two methods are discussed. They are ponding and spraying. According to the Russian engineers, both ponding and spraying of roofs can be very effective in hot climates, but they are not without problems. Basically, ponding adds weight to the roof structure and must be included in the design of the building. Ponded roofs must be protected from algae and plant growth. Spraying is a method of intermittently applying a fine mist so that water is always evaporating from the roof and never running off. Spraying uses more water than ponding and can cause thermal shock to the roof membrane.[10]

With insulation and especially with fiber glass felt, workmanship is of prime importance. No matter how carefully all the materials that go into a built-up roof are manufactured, they will not perform satisfactorily in the roof structure unless they are properly assembled. In Florida, installing a built-up roof, particularly at certain times of the year, can be very demanding. For the roof to go together properly, the roofer should ".... install only dry materials in dry weather."[11] But given the local weather and the materials required, the roof must still be placed with skill and care. Problems can be caused by wrinkled plies of felt, bitumen that is too hot or too cold, foreign matter between the plies, improper brooming of the felts, improper connection of the base sheet to the roof deck, improper placement of flashings, traffic over finished parts of the roof and improper handling and storage of materials on the roof, to name just a few.

Training roofing applicators to be aware of all of the possible problems mentioned above and more is an ongoing problem with roofing contractors. Many of the better contractors conduct classes on days when the weather will not allow outside work. In spite of the best efforts of the roofing contractor, there will be times when he is not on the job at a time when one or more of these problem-causing happenings will occur. On a visit to a roof under construction in Central Florida, it was found that damp felt was being mopped in place with 600 degree asphalt. Ahead of the mopping, the crew was cutting holes in the deck, leaving dust and trash to be mopped between layers of the deck. There is no way to get enough asphalt between the plies when the asphalt is that hot, and further, 600 degrees is within 25 to 50 degrees of flash point for the asphalt, meaning that an explosion or fire at the heating kettle was a distinct possibility. This was a hardworking crew, and they were not trying to cut corners; they simply needed guidance. Had there been a member of the roofing contractors quality control team or a quality control person there for the owner, this group could have very easily, at less danger to themselves, put on a first-class roof.

On that same trip, time was spent watching another roof being replaced by a new roof. There was a knowledgeable person on this job representing the roofer, and the job was well organized. As the old roof was torn off, the deck was cleaned. Right behind the cleaning crew came the crew putting down the roof. Felts were being rolled out straight and level and mopped with asphalt at the correct temperature. The amount of asphalt between plies was correct and a good roof was being swiftly

and neatly applied. The difference between this roof and the one mentioned before is essentially knowledge and quality control.

For quality control to be effective, it must be based on a proper specification. Most roofing specifications are drawn up by architects, and architects are very unlikely to get any training in this discipline as part of their college education. According to well-known roofing consultant Paul Tente, there is only one major university, Indiana, in the United States that teaches roofing construction.[12] Thus, if an architect has not gone to some trouble on his own to get an education on roofing, he is quite likely to pick his roofing specification out of Sweets Catalogue. This is to say, the manufacturer specifies a roof, but not necessarily for the type use for which it was designed. When an architect does educate himself on roofing matters, the results can be tremendous. When talking to Mr. Vann Rhodes, Director of Development for the Department of Housing and Urban Development in Dade County, it came to light that he is not having roof trouble with the roofs on the apartments that he designs.[13] When interrogated about this, Mr. Rhodes, who is an architect, stated that buildings for which he is responsible have roofs specified that are known to be satisfactory in the area. He further stated that as each roof was being built, a knowledgeable quality control inspector was assigned to the project. Tried and true materials, properly installed, will usually give a satisfactory job. Mr. Rhodes specifies 4 plies of fiber glass felt with 20 pounds of asphalt mopped between each ply, and a gravel top course for his roofs.

Mr. Rhodes, as well as other people interviewed during this investigation, emphasized the importance of a regular maintenance program for built-up roofs. Many people who build a new building ask for a "20-year bonded roof" and plan not to look at the roof for at least 20 years. The roof should be examined at least twice a year, and at that time drain strainers should be cleaned, dried caulkings should be replaced and cracks and blisters should be repaired before they become leaks. These inspections should be conducted by someone with a good background in roofing technology and action should be taken on the findings at once. Once a leak begins, then it is quickly compounded by wet insulation, and damage to buildings and contents follows.

These investigations and interviews constitute a sampling of the investigator's efforts in on-the-site inspection and personal contact in searching for data pertinent to roof failures in Florida.

ACCOMPLISHMENTS

A search for a record of roof failures was done in order that a statistical summary of them could be made. Usable records of failures do not exist; see Appendix 1 and 2. On close examination, there are several reasons which may explain why these figures are unavailable. First, there is no single definition of roof failure. Is failure the first sign of water penetration, which might be caused by poor maintenance, or does failure occur when it becomes too expensive to repair the roof and it must be replaced, or is it somewhere between these two extremes? In any case, roofs fail for several reasons, including:

1. Poor design on the part of the specifying authority.

2. Poor workmanship on the part of the installer.
3. Improper selection of materials for existing conditions.
4. Poor quality of materials.
5. Lack of quality control during installation.
6. Failure on the part of the owner to maintain his roof.

Secondly, no one is proud of failure, and therefore the information is not easily gathered.

This research has pinpointed the needs for the proper definitions, as well as the need to start keeping long term records of various problems. Preliminary steps have been taken, in cooperation with the FRSA, to collect this information, but it will be at least another year before statistically valid results are available.

RECOMMENDATIONS

The gathering of roof failure information should be expanded to gather information on all types of failures and problems over a period of several years. This data could be studied to arrive at the most efficient way of minimizing the problems encountered.

Roof decks should be included in future studies. Various types of decks deflect differently under similar loads and they have different coefficients of expansion. Cast in place decks, such as concrete and gypsum, retain various quantities of moisture that must be vented away. Information on various types of decks and the most satisfactory roof

membranes for each would give architects a basis for selecting the proper roof covering for each type of deck.

There is a need to educate the specifiers of roofs. Architecture students should at least be exposed to seminars on roof deck and roofing design, since they will become the people who specify roofs in the future. They should be taken on field trips to study and learn the proper techniques for applying good roofs, since it will become their responsibility to see that their specifications are built into future roofs.

New roofing materials and roofing systems offered for use in Florida should be tested in an unbiased way as soon as they become available. This information should then be made available to specifiers and roofers as soon as possible.

Something similar to the Institute for Building Research of the Pennsylvania State University should be set up to continue research into roofing, and other building materials specifically related to Florida. A logical place for such an institute would be the School of Building Construction of the University of Florida.

National Roofing Contractors Association

Project Pinpoint Report

(Each number represents a percentage of that year's failures assigned by state and type.)

Definition Of Failure Causes Used In National Roofing Contractors Association Project Pinpoint Report

Blistering-	The formation of blisters in the roofing membrane. Caused by mositure trapped between the plies.
Splitting-	Splits in the top of the roofing membrane caused by movement of roofing, usually at a joint in the deck or the insulation.
Ridging-	The formation of sharply defined ridges, frequently in the same areas as splitting (above).
Buckling-	Similar to blistering and ridging above and frequently caused by a combination of moisture and movement.
Ply Separation-	Happens when the various plies of a roof fail to bond to each other. This condition makes moisture penetration easier.
Fish Mouths-	Small half round unbonded areas at the edge of one ply of a roofing membrane. Each one is a possible entrance for water.
Slippage-	Occurs when all or part of a roofing membrane on a sloped surface overcomes its anchoring method and moves down the slope.
Blow-Offs-	Condition that occurs when wind forces overcome anchoring methods and all or part of a roof membrane leaves the building.

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		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-Of
AK	1974								
	1975								
	1976								
	1977								
	1978								
	1979		1.1						
	1980					1.1			
AL	1974								
	1975								
	1976	1.2							
	1977	2.2							
	1978								
	1979								
	1980								
AZ	1974								
	1975								
	1976	2.3							
	1977	2.2							
	1978								
	1979								1.2
	1980								
AR	1974								
	1975								
	1976		1.2						
	1977		4.3						
	1978								
	1979								
	1980			1.4					
CA	1974	5.2							
	1975								
	1976	1.2	1.2						
	1977	2.2	2.2						
	1978	3.4							
	1979				1.1				
	1980	2.9	4.3	1.4					

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-O
CO	1974								
	1975								
	1976	2.3							
	1977								
	1978								
	1979								
	1980					1.4			
CT	1974	1.3	2.6						
	1975								
	1976								
	1977								
	1978								
	1979								
	1980				1.4				
DC	1974								
	1975								
	1976	1.2							
	1977								
	1978								
	1979								
	1980								
FL	1974								
	1975								
	1976		1.2	1.2					
	1977								
	1978								
	1979								
	1980								
GA	1974								
	1975		1.3						
	1976		4.2						
	1977	4.3							
	1978	5.1							
	1979								
	1980	5.8				1.4			

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-O
HI	1974	1.3							
	1975								
	1976		1.2						
	1977	2.2							
	1978								
	1979								
	1980								
ID	1974								
	1975								
	1976								
	1977		2.2						1.2
	1978								
	1979					1.7		1.7	
	1980								
IL	1974	2.6	1.3						
	1975		8.3						
	1976								
	1977								
	1978					2.2			
	1979								
	1980								
IN	1974	1.3	1.3						
	1975						1.3		
	1976		2.3						
	1977		2.2						
	1978	3.4	6.8						
	1979								
	1980								
IA	1974								
	1975								
	1976		2.3						
	1977	2.2							
	1978			1.7					
	1979								
	1980		1.4						

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-O
KS	1974								
	1975								
	1976	2.3							
	1977		2.2						
	1978		3.4						
	1979								
	1980								
KY	1974								
	1975								
	1976								
	1977		2.2						
	1978								
	1979								
	1980								
LA	1974								
	1975								
	1976		1.2						
	1977								
	1978								
	1979								
	1980								
ME	1974	1.3							
	1975								
	1976								
	1977								
	1978		1.7					2.2	
	1979								
	1980								
MD	1974	1.3							
	1975							2.6	
	1976	1.2	1.2		1.2				
	1977		2.2						
	1978								
	1979								
	1980								1.4

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-O
MA	1974	3.9	3.9		2.6	2.6			1.3
	1975								
	1976								
	1977		2.2						
	1978		1.7						
	1979								
	1980		1.4		1.4				
MI	1974		3.9						
	1975		4.2		4.2				
	1976								
	1977	2.2							
	1978								
	1979								
	1980		1.4						
MN	1974								
	1975								
	1976								
	1977	6.5	2.2						
	1978	1.7							
	1979								
	1980		1.4						
MO	1974								
	1975								
	1976								
	1977		4.7						
	1978								
	1979								
	1980		1.4			1.4			
MT	1974								
	1975								
	1976		4.2						
	1977								
	1978								
	1979			1.7					
	1980								

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-O
NE	1974								
	1975		1.3						
	1976								
	1977								
	1978								
	1979								
	1980								
NV	1974								
	1975								
	1976								
	1977								
	1978								
	1979								
	1980	2.9							
NH	1974								
	1975								
	1976								
	1977								
	1978								
	1979	1.7							
	1980	1.4							
NJ	1974								
	1975								
	1976								
	1977								
	1978								
	1979								
	1980	1.4							
NM	1974								
	1975	3.4							
	1976								
	1977								
	1978								
	1979								
	1980								

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-Of
NY	1974	6.5	3.9						
	1975		4.2						
	1976	1.2							
	1977	4.3							
	1978		3.4						
	1979								
	1980	4.3	1.4			2.9			
NC	1974		1.3						
	1975								
	1976	1.2							
	1977		2.2						
	1978	1.7							
	1979								
	1980	1.4	2.9	1.4					
ND	1974								
	1975								
	1976								
	1977		6.5						
	1978	3.4							
	1979								
	1980								
OH	1974		2.6						
	1975	4.2		4.2					
	1976	4.7	3.5						
	1977	2.2	2.2	4.3					
	1978		3.4						
	1979								
	1980	1.4							
OK	1974								
	1975								
	1976								
	1977								
	1978								
	1979								
	1980							2.9	

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-O
OR	1974								
	1975								
	1976	1.2							
	1977								
	1978								
	1979								
	1980								
PA	1974								
	1975	3.5	3.5			2.6			
	1976								
	1977								
	1978	1.7	1.7	1.7	3.4				1.7
	1979								
	1980	1.4		2.9	1.4				
RI	1974								
	1975		1.3						
	1976								
	1977								
	1978								
	1979								
	1980								
SC	1974								
	1975	5.2							
	1976								
	1977	2.3	1.2						
	1978								
	1979								
	1980	5.8							
TN	1974								
	1975	1.3	1.3						
	1976								
	1977	1.2							
	1978								
	1979								
	1980					1.4			

		Blistering	Splitting	Ridging	Buckling	Ply Seperations	Fish Mouths	Slippage	Blow-Of
TX	1974								
	1975								
	1976	1.2		1.2					
	1977			2.2					
	1978	1.7							
	1979								
	1980	1.4	1.4						
UT	1974								
	1975		3.9						
	1976	8.3							
	1977								
	1978								
	1979								
	1980								
VA	1974								
	1975								
	1976								
	1977	2.3							
	1978								
	1979	1.7							
	1980								
WA	1974								
	1975								
	1976								
	1977	1.2							
	1978								
	1979	1.7							
	1980								
		2.9							
	1974								
	1975								
	1976								
	1977								
	1978								
	1979								
	1980								

Fiber Glass Felts Surveys

Information gathered by

Florida Roofing, Sheet Metal & Air Conditioning
Contractors Association, Inc.

COMPARISON OF FIBER GLASS FELT SURVEY RESULTS

Survey #1 tabulated 11/80
Survey #2 tabulated 7/81

1. % of respondents who have used the products:

11/80	77% (37 of 48)	
7/81	76% (34 of 45)	

2. Number of jobs on which the product was used:

11/80	0-5	31% (11)	7/81	24% (8)
	6-20	33% (12)		41% (14)
	21-50	11% (4)		24% (8)
	51-100	25% (9)		9% (3)
	More than 100	0%		3% (1)

3. Brands used:

11/80	Celotex	13% (11)	7/81	12% (10)
	J-M	24% (21)		26% (22)
	GAF	13% (11)		17% (11)
	Tamko	7% (6)		7% (6)
	Certain-Teed	10% (9)		11% (9)
	O-C	30% (26)		27% (23)
	Other	2% (2)		0% (0)

4. Advantages listed include:

	11/80	7/81
Use of steep asphalt	1	0
Tensile Strength	8	5
Not curling or blistering	12	7
Weathering ability	6	3
Cheaper	1	5
Less rolls of material needed	5	6
Lighter	11	9
Labor savings	7	7
No rot or shrinkage	1	0
Salability	1	0
Ease of application	0	5

5. Disadvantages listed include:

	11/80	7/81
Floating in asphalt while rolling in	1	0
Uses more asphalt	4	3
Interply separation	2	0
Lack of asphalt absorption	3	0
Skin irritation	4	1
Pin holes	2	0
Price	5	2
Requires more careful handling	1	5
Bad odor	1	0
Flashing difficulties	3	1
Water seeping through mat	0	2
Memory	0	1
Vulnerable to traffic	0	6

6. The percentage of problems reported when using fiber glass felts was:

	11/80	7/81
0% -	67% (20)	73% (24)
1-5%	20% (6)	24% (8)
6-10%	3% (1)	0% (0)
11-20%	0% (0)	6% (2)
30%	3% (1)	3% (1)
50%	0% (0)	3% (1)
75%	3% (1)	0% (0)
100%	3% (1)	6% (2)

6a. The nature of problems reported in the 7/81 survey included:

Floating of mat due to excess parting agent
Fishmouth
Base sheets sticking to roof deck
Water seepage through mat
Leaks in middle of roof for no apparent reason (3)
Traffic problems (2)
Flashing problems
Ply separation
Voids in asphalt

7. Handling hints suggested were:

	11/80	7/81
Mop cooler asphalt	2	0
Use extra asphalt	7	5
Careful rolling to avoid buckles	2	1
Felts must be broomed	7	2
End of roll must be protected	1	0
Needs better than average workmanship	2	11
Avoid all traffic before cooling	1	4
Use heavier base sheet	0	2
Don't use	0	1

8. Comments made on 7/81 survey:

I like the product. (15)
Looks good so far but needs more time. (3)
We have lost many good customers and a lot of money on the product.
It's a better system than others when installed correctly. (3)
We do not encourage the spec though we will do it.
Expensive.
Use extreme care in crew selection for fiber glass work.

ABBREVIATIONS

ASTM	American Society of Testing Materials
BUR	Built-up Roof
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association
NBS	National Bureau of Standards
NRCA	National Roofing Contractors Association
RH	Relative Humidity
STAC	NASA - Florida State Technology Applications Center

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