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DIVISION OF BUILDING RESEARCH

PROPOSALS FOR ROOFING RESEARCH IN CANADA

A BITUMINOUS ROOFING INDUSTRY VIEWPOINT

by

Donald J. Smith

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PREFACE

The Division of Building Research was created to serve the research needs of the Canadian construction industry. In planning its research projects, therefore, the Division has responded to input coming from industry in the form of inquiries and requests. At times the Division sought further advice and opinion through direct approach. This report represents one such contact with the Bituminous Roofing Industry through Mr. Donald J. Smith acting on behalf of the Division.

Mr. Smith served Building Products Ltd. for many years in their technical department and is highly qualified to speak on the subject of research needs of the Bituminous Roofing Industry. In this report he integrates his experience with that of other experts in the industry to present a comprehensive viewpoint.

Ottawa
November 1972

N.B. Hutcheon
Director

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Perspective

Roofs in Canada annually covered with bituminous roofings total about 780 million ft^2 (28 $miles^2$) with only 3 to 5 $miles^2$ covered by other materials. The estimated value of built-up roofing (B U R) installed annually in Canada amounts to over $110 million while shingles come to approximately $90 million (at $20/sq). Installed roll goods and coatings, etc., cost consumers at least $14 million. It is obvious that the integrity of bituminous roofings is economically important.

Roofing exports amounted to about 15 per cent of total Canadian production in 1971. A summary of the production data regarding these products is given in Tables 1 and 2.

About 200 million ft^2 out of 780 million, is B U R. This compares with 2,000 million ft^2 of B U R installed annually in the United States of America; i.e. a 1:10 ratio. C.W. Griffin reported that 10 to 15 per cent of B U R roofs in the U.S.A. fail prematurely, (in less than 15 years), the incidence of failure being higher in colder areas.[1] At the 15 per cent rate, 30 million ft^2 (300,000 roofing squares) can be expected to fail prematurely in Canada each year. This amounts to premature problems on roofings valued at about $16.5 million, exclusive of the roof deck (see Note (1))*. Since the cost of replacing these roofs may be double the original cost, efforts to reduce the incidence of failure are worthwhile.

The Real Estate Division of CMHC reports the cost of installing a B U R roof as $55 per square and of re-roofing as $100 per square, confirming the figures cited above. However, widespread experience of CMHC indicates that the failure rate may be much higher than that indicated in Griffin's report. About 25,000 squares of roof, on 700 buildings located from Calgary to Montreal, containing 5,000 housing units and built 12 to 15 years ago, have failed completely. Replacement of the roofs on all of these buildings will have been completed by December 1973.

*Notes are included at the end of this Report.

This survey involves many aspects of the roofing industry, as seen in Appendix I. The writer has attempted to synthesize opinions, facts, suggestions and needs into a coherent statement.

Industry Needs

The needs of the Industry fall into 2 general categories:

1. Technical assistance - to solve the problems relating to the failures of the materials and systems in performing their functions for a reasonable period of time.
2. Technical information - to provide technical information that can be used for the education and training of those involved in the design and installation of roofs and to assist in the export of the products.

Technical Problems - General

Perhaps the most important problem facing both producers and consumers of bituminous roofings is the long term prospect of diminishing supplies and increasing prices of bitumens, e.g. the price of asphalt increased by 40 per cent in 1971. Hence there is a strong incentive to conserve bitumen. While the situation applies to asphalt, coal tar and pitch, asphalt composes 95 per cent of the business and will be considered further.

It is recognized that the Asphalt Roofing Industry is best fitted to develop shingles as well as B U R systems that would decrease the amount of asphalt required per unit area of roof covered.

It is possible to reduce the quantity of asphalt consumed in B U R by replacing the hot flood coat with an asphalt emulsion coating. 20 lb of hot asphalt in an emulsion could probably replace the 60 lb per square now used. This would be a reduction of 40,000 tons per year, valued at $2.2 million. It is relevant to investigate the merits of hot and cold systems (a) without gravel on the emulsion coating, (b) with gravel embedded in the emulsion.

The proportion of mineral stabilizer for asphalt roof coatings may be increased. For shingles, each 5% increase in stabilizer content would save roofing manufacturers about $225,000 per year at present costs and volume (Note 2). It is suggested that the maximum may reach 15 per cent above the present weight limit of 55 per cent. This could save up to $2.4 million per year.

Roofing granules - It has been suggested that the present size grading of granules may not be optimum. If the present usage of granules for shingles and mineral surfaced roll roofings were reduced by 10 per cent as a result of improved gradings, the savings to the manufacturers would be about $0.55 million per year (Note 3). At a factor of 3.3 this amounts to $1.8 million to the roofing consumer.

The above suggestions however, rely heavily on the ability to evaluate and specify cheap yet adequate materials and systems.

Recommendations

(1) Establish optimum grading of roofing granules to provide maximum protection to roofings at minimum weight. The protection would be against (a) sunlight, i.e. ultraviolet rays, and (b) fire. Determine whether any reduction in the weight of granules per unit area could be reflected in the over-all weight of the roofings shipped, or whether the difference would have to be made up by increasing the amount of coating used. If the over-all weight could be reduced without increased coating the savings in freight costs could be reflected in the price to the consumer.

(2) Replace roofing granules with some less expensive material. Roofing granules used in 1971 had a value of $5.5 million at $25 per ton.

(3) Provide for large-scale testing of new roofing products and systems including their subjection to realistic simulation of fire, wind, hail, frost, rain, snow, ice and sunshine versus time. The co-operation of manufacturers, contractors, architects and owners might be arranged. As can be seen, such a move would promote this field.

Technical Problems with Asphalt Shingles

Shingles (as opposed to B U R) cause water entry in houses as a result of ice dam formations along the eaves. Water collecting on the shingles above the dam becomes deep enough to overflow the headlap of the shingles and penetrate through the deck. The problem is, to some extent, regional and may have to be approached from that standpoint. Repairs have been both extensive and expensive. It is recognized that this may be mostly a design problem and solutions must be sought in terms of the total system.

Recommendations

(1) Problem areas should be mapped and regions where these roofs create the most serious problems should be established.

(2) The value of protection strips along the eaves should be determined and, if useful, they should become mandatory in the codes of the areas.

(3) Research should be undertaken to determine new and fool-proof solutions to the problem; this would include ventilation of eaves, heating cables, different types of eaves and different shapes of roofs which would encourage winds to disperse the snow.

Technical Problems with B U R Systems

Problems of cracks or breaks in B U R roofing membranes resulting in water leakage have been described in various publications and have been attributed to various causes. In this report it is sufficient to note that the Industry does not know precisely why the membranes break or how these costly failures can be avoided. The Industry believes that more research should be carried out to help solve this problem.

There is insufficient information available on the needed strength of roofing laps and on the method of measuring this strength. Failure of laps to hold is a major cause of B U R roofing failure. We estimate that roughly $2 - $15 million per year of repairs are involved.

Moisture passage and its accumulation in roof decks and membrane systems plays a major part in roof failures and, in many instances, particular features such as lightweight insulating concrete, installation of vapour barriers, foamed insulation etc., all contribute to the performance of the roofing. A systematic evaluation and documentation of the effect of the different components would assist the Industry greatly. This should include the newly proposed system of insulation placed on top of the membrane.

Deck criteria

Roof decks are being designed to provide structural integrity; not necessarily to support properly a roof membrane. Work is required to provide information regarding good engineering design. This should include concrete, lightweight insulating concrete, steel etc.

Wet seal cements

There is a real need for bituminous cements which can be used to seal breaks in roofing membranes, shingles and flashing during cold, wet weather. Many leaks are detected when snow and ice are melting on the roof. Rapid repairs, even if only to stop the leak for a few months, can prevent extensive damage to the interior of buildings or to insulation under a membrane. Such repairs, if performed in time, make possible relatively inexpensive repairs during later warm weather. B U R repairs, which might cost $10,000 for a 100-square section of roof if ineffective cements were used, could then be produced for as little as $100 to $1,000. Sometimes even a gallon of cement and a couple of hours time are all that is involved in making a permanent repair. If only 10 per cent of the 300,000 squares of B U R which require maintenance each year were treated as above, some $30,000 to $300,000 might be saved in repair costs.

There is a need to modify the present B U R systems so that they can be maintained more easily. One difficulty involves the attachment of gravel to the pour coat which requires that it be scraped off before repairs can be made. In Europe, the flood coat is allowed to chill; a 2-in.-thick layer of water rounded $\frac{1}{2}$-in.-gravel is then spread. This type of gravel sweeps clean for repairs.

CMHC, and others, have had trouble with roofs which hold water in shallow ponds. CMHC cites the failure of 30 roofs in Saint John, N.B. and others in Ottawa and elsewhere, in as little as 3 years, to illustrate the need for more information. Reports indicate that failure in the membrane coincides with sudden cold spells and loud bangs from the roof, followed by melting.

Recommendations

(1) It has been suggested that research be directed towards providing fundamental engineering properties of the asphalt and asphalt-membrane composite in order that the basic design questions be answered. At present there is no adequate basis for prediction of performance except experience which seems to fail in at least 15% of the cases.

(2) There is a need to develop a performance type of test procedure which would evaluate the B U R membrane, especially where the components and design features are varied. Such a test could also serve to evaluate the performance of wet-seal cements that could be developed for temporary sealing of leaks in a membrane. Similarly, it can be used to evaluate new roofing membranes and systems.

(3) Develop strength-of-lap (bond) test between felts and asphalts including bonding to the deck and insulation.

Information Assembly and Dissemination

1. Information required for Export Market

Exporters find themselves without ready access to help in dealing with the code and specification authorities of other nations, such as F H A in the U.S.A. and C S T B in France.

There is a scarcity of published authoritative information about the properties and behaviour of asphalt shingles in Canada. Because of the gradual growth of their use, many of those attributes, which have made them the preponderant roofings here, are taken for granted. Documentation is either difficult to find or is non-existent. When a Canadian exporter offers asphalt shingles in France, Japan, Australia, or other countries, he is asked to document such things as life-expectancy, contribution to fire or fire protection, and relevance of specifications to performance claimed. Unless such information can be supplied, regulatory agencies of the importing country can be subjected to severe criticism by established local industries and trades.

An example of the paucity of published information is the situation about the spread of fire. Many Canadians remember when whole villages burned to the ground because flying brands spread the fire from one wood-shingled roof to another. The gradual replacement of wood shingles by asphalt shingles has contributed greatly to the elimination of such conflagrations. The supporting literature to demonstrate this convincingly to a skeptical overseas market is not available. Nor is this resistance of asphalt to the spread of fire taken into account when estimating insurance rates because there are now so few concentrations of wood shingle roofs it no longer pays the insurance companies to make a distinction.

Again, we know that the best information we have in Canada has gone into the writing of the pertinent CSA specifications which is similar to ASTM. These are recognized as providing a whole group of performance characteristics at a minimum, but commercially acceptable, level. However, the supporting statistics and documentation are often not available to the exporter.

The roofing industry and supporting government services in Canada are thus unable to supply the back-up information to help expand what is presently a $4 million per year part of the shingle market. There is every reason to believe that the prospective market is relatively unlimited.

Recommendations

It is recommended that authoritative technical information now available be prepared and published in appropriate form to cover the following topics with regard to asphalt shingles: life expectancy (performance) under different weather conditions; fire resistance characteristics (especially as compared to wood shingles); and, performance under impact and wind loads.

There is a need to generate more information which could be published to assist the export market. Interest has been shown in France and Japan in the method of applying asphalt shingles to concrete decks, as well as to a variety of fiberboards; technical guidance is required however. Similarly, there is a shortage of technical information on various aspects of durability of asphalt shingles which might be applied to predict performance in different climates: freeze-thaw, wind resistance, ultraviolet irradiation and humidity. Introduction of asphalt shingles to countries like Kenya requires that Canadian experiences be applied to the prediction of performance in other countries.

2. Information required for domestic market

There is a need by the Industry to develop criteria for the performance of roof systems and their various components:

Deck criteria

Roof decks are being designed to provide structural integrity; not necessarily to support properly a roof membrane. There is need for published deck design criteria related to the deck's function in supporting the whole roofing system plus the dead and live loads imposed upon it. This should include concrete, lightweight insulating concrete, steel, etc.

Roof insulations

The industry recognizes a need for a publication comparing the properties of roof insulation materials and relating them to the requirements of roofing systems. This is particularly urgent for the plastic insulations such as polystyrene foams and polyurethane foams, but might include others like fiberboards, glass foams, phenolic foams, etc.

Vapour barriers

There is confusion among roofers regarding this element of roof systems. It is necessary to develop and publish criteria for the use and 'non-use' of vapour barriers. Methods for venting roof insulation should be studied. Are the venting systems used in Europe satisfactory under Canadian conditions?

Recommendations

It is believed that comprehensive field surveys and assembly of performance records of the various types of roofing materials and systems (including cathedral and Mansard roofs) would assist greatly in providing the necessary information for the formulation of criteria of performance. Performance of new materials and design features can be related to experience with the traditional 4-ply B U R.

List of specific questions and requests posed by the Industry

(1) Study polyurethane foamed-in-place membranes to develop more information on the limitations of these materials.

(2) Study what happens to roofs in cold weather when flow-restricting drains are used.

(3) Study the use of a 'temporary roof' required for winter closure of buildings. It is recognized that early failure of standard roofs occurs more often when they are applied in cold weather. A minimum 'temporary roof' which would permit application of a standard B U R in the following season of warm weather would be one approach to the problem. One company suggests use of a coated felt, 1-ply, lapped 9 in., using cut-back adhesive on a primed deck and employing a heat-seal roller.

(4) Study the effect of ring drains on roofings, problem of crushing and the need for flanged drains to spread pressure.

(5) Study elastomeric flashing materials: weather resistance, age hardening, bond and adhesion failure, creep, fracture, oxidation and curl, including effects of chemicals, U.V. and temperature on stress/strain/time relationships.

(6) Prepare specifications for asphalts to be used in adhering roofing systems to steel decks.

(7) Study the effects of asphalt coal tar or coal tar pitch contacts in roofing systems.

(8) Study the effects of contact incompatibility between bitumens in B U R systems. How important is it in hardening or softening of adhesive layers and of flood coats; in blistering; in adhesion; in slippage; in accelerating weathering. The mechanisms involved are not known and therefore their study would be justified.

Reference

[1] Manual of Built-Up Roof Systems, by C.W. Griffin for the American Institute of Architects, McGraw Hill Book Company Inc. Copyright 1970.

Notes

(1) This cost is based on current estimates by roofers for a 200 square roof, on a two-storey building and includes gravel stops and minimum glavanized flashings:

	$ Per Square
4-ply B U R with gravel, etc.	$30
1 inch fiberboard insulation	15
Vapour Barrier	10
Installed cost	$55

(2) Possible savings from changing the proportions of asphalt roof coatings

Asphalt Roof Coating Composition	Equal Proportions %	Cost $/Ton	Increased Stabilizer %	Cost $/Ton
Mineral Stabilizer	50	3.00	55	3.30
Asphalt	50	13.50	45	12.15
		$16.50		$15.45

The reduction in the cost of the roof coating for a 5% increase of stabilizer content with 5% reduction of asphalt content will be $16.50 - $15.45 or $1.05 per ton of roof coating.

Products Using Coating	Annual Volume 1971 (Table I) Square	Coating/Square Pounds	Total Coating Tons	Saving For 5% Stabilizer Increase
Shingles	5,165,111	74	191,109	$200,664
Coated Felt	1,862,034	25	23,275	24,439
				$225,103

(3) Possible savings from reducing the use of mineral granules

Products Using Granules	Annual Volume 1971 (Table I) Squares	Granules Per Square Pounds	Total Granules Tons	Cost at $25 Per Ton
Shingles	5,165,111	80	206,604	$5,165,100
Mineral Surfaced Roofing	830,804	36	14,952	373,800
				$5,538,900

Total value of granules used = $5.5 million. 10% reduction in use represents $0.55 million per annum.

TABLE 1

CANADIAN BITUMINOUS ROOFING PRODUCTS

MANUFACTURERS' SHIPMENTS OF OWN GOODS

PRODUCT	VOLUME (1) Export	VOLUME (1) Total	(2) $ / Unit	Value '000$ Export	Value '000$ Total
Shingles, 210 lb and over, squares	670,261	5,034,198	5.92	3,968	29,802
Shingles, less than 210 lb "	5,012	130,913	5.32	27	696
Shingles, total, squares	675,273	5,165,111		3,995	30,498
Smooth surface roll roofings					
45 and 55-lb types, squares	64,707	563,120	1.87	121	1,053
33, 40 and 53-lb squares	10,026	468,110	1.87	19	875
Mineral surfaced roll roofings					
and sidings, squares	117,378	830,804	2.93	344	2,434
Tar and asphalt felts, tons	18,339	96,349	29.30	537	2,922
Tar and asphalt sheathings, tons	65	7,946	116.	8	922
Roofing pitch, tons	--	6,101	105. (3)	--	641
Roofing asphalt, tons	--	138,946	55 (3)	--	7,642
Bituminous paints, cements and coatings					2,951 (2)
TOTALS				5,024	49,938

(1) Manufacturers' Shipments, 1971, D.B.S. Catalogue 45-001

(2) Based on volume and value of Manufacturers' Shipments, 1969 D.B.S. Cat. 36-205

(3) Estimated consumer prices, 1971.

TABLE 2

CANADIAN BITUMINOUS ROOFING PRODUCTS (Re-calculated from Table 1)

MANUFACTURERS' SHIPMENTS OF OWN GOODS

Product			Volume 10^6 sq(1)	Value 10^6 \$	Cumulative Value 10^6 \$
Shingles			5.165	30.498	30.498
Built-Up Roofing	10^6 sq(1)	10^6 \$			
Saturated Felts, 4-ply	1.955	1.778			
Coated B U R Felts, 4-ply	0.117	0.875	2.072(2)	2.653(2)	
Bitumens, 145 047 tons	2.072(2)	8.283		8.283	10.936
Sundry Roll Goods					
Saturated Felts 37 696 tons 1.257 (4-ply)(3)				1.144	
Smooth Surfaced Roofings, 45 and 55-lb			0.563	1.053	
Mineral Surfaced Roofings and Sidings			0.831	2.434	
Sheathings, 7 946 tons				0.922	5.553
Paints, cements and coatings				2.951	2.951
Total Value				49.938	49.938

(1) Sq = Roofing Square = Area of material required to cover 100 sq ft of roof.

(2) Calculated on basis that all the bitumen was used at the rate of 140 lb per 4-ply-square and that all B U R was 4-ply, including 33, 40 and 53-lb smooth surfaced rolls (Coated B U R Felts)

(3) Other uses than B U R. This includes export.

APPENDIX I

The following firms and individuals have been very helpful in contributing time, information and suggestions.

1. United States Bureau of Standards
   - Wm. C. Cullen
   - Robert G. Mathey
   - A. Philip Cramp

2. Central Mortgage and Housing Corporation
   - Howard Work
   - A.W. McIntyre
   - Carl McAvoy
   - John A. Spanier

3. Canadian Roofing Contractors' Association
   - Jacques Chevalier
   - Paul Tree
   - B.L. Quincey

4. Ontario Industrial Roofing Contractors Association
   - A.D. Fulford

5. Quebec Master Roofers Association
   - Henri D. Lamarre
   - Robert McCall
   - Technical Committee

6. Building Owners and Managers Association of Montreal Inc.
   - David S. Keast

7. Protestant School Board of Greater Montreal
   - Harold Silvia
   - James Zaferis

8. Donald Inspection
   - Wm. C. Viner

9. D.M. Belyea & Associates Ltd.
   - D.M. Belyea

10. Warnock-Hersey
    - Hubert Brosseau
    - Arthur Hazel
    - Rolland Leduc

11. Building Products of Canada Limited
    - Dr. S.A. McIntosh
    - W.C. Harrison
    - Travor Braithwaite
    - T.E. Holt
    - Harold D. Olmstead
    - H.E. Saint-Amour
    - Lewis Waite

12. Canadian Gypsum Co., Ltd.
    J.L. Payne
    Frank E. Ladner

13. Domtar Construction Materials Ltd.
    Borden Marshal
    Paul G. Levasseur
    Marc A. Collet
    Cy Bulkis

14. The Flintkote Company of Canada Limited
    Clarence C. Weeks
    James J. O'Brien

15. Iko Industries, Ltd.,
    Henry Koschitski

16. Imperial Oil Limited
    Henri Sergi

APPENDIX II

Building Research Division

U.S. Bureau of Standards

Proposal to the Tri-Service Committee on

Project 4212447 on Performance of Roofing

FY 71

Objective: To obtain data and information based on laboratory, outdoor exposure and field experience of the causes of built-up roof slippage. To develop a criteria for design and a specification for material characteristics to alleviate such failures.

Background: The failure of roofs by the separation of part of the membrane system from the roof has been increasingly noted in recent years on new military roof construction. This roof slippage occurs within the first year of construction and is usually associated with a built-up asphalt roof system having insulated decks, successive days of high temperature, sloped roof with mineral surfacing. Factors of prime consideration in the roof system which seem to contribute or coincide with the failures are bitumen viscosity and bitumen surface bonding characteristics. The repair of a roof which has failed by slippage is costly and difficult. Often the only solution is complete removal and replacement.

Approach: The investigation will be undertaken in four tasks: bitumen characteristics, roof design characteristics, simulated roof exposure and recommendations.

Task 1, Bitumen Characteristics: Softening point, shear viscosity, shear force, and flow characteristics will be calculated and measured on a selected variety of roofing bitumens to establish relation to temperature and storage. The study will include roofing asphalts from different refineries, hot storage tanks, heated kettles and applied roofs.

Task 2, Roof Design Characteristics: Calculate forces related to weight and slope of roof and measure such forces in the laboratory on membrane systems to study effects of:

a) bituminous characteristics
b) bitumen thickness
c) temperature
d) membrane construction
e) type of felts and base sheets

Task 3, Simulated Outdoor Roof Exposure: Expose roof panels of different construction and with varying component characteristics to low, moderate and steep slopes on outdoor exposure sites to measure slippage and establish correlation with data from Tasks 1 and 2.

Task 4, Recommendations: Based on above data provide construction details and material type characteristics for slippage-free built-up roof systems at slopes up to 6 inches in 12 inches.

Estimated Cost: $30,000.

APPENDIX III

Proposal to the Tri-Service Committee on
Project 4212447, Performance of Roofing
FY 72

Objective: To obtain data and information based on laboratory and field experience of the causes for adhesion failures of roofing systems using coated base sheets. To develop testing procedures for material characteristics of coated base sheets to alleviate such failures.

Background: Adhesion failures of roofing systems using coated base sheets have become prominent with the increased use of this material. Problems of adhesion failures shortly after completion of a job and in fact on occasion prior to completion of a job have become prevalent. Adhesion failures are generally manifested by large blistered areas that are caused by entrapped moisture and result in continuing maintenance procedures. Although immediate leakage may not result from a roof that is extensively blistered the serviceability and expected life of such a roof is certainly affected. Present knowledge of the problem indicates that adhesion failures between plies of base sheet occur as well as loss of adhesion of base sheet to substrate. The repair of a roof which has failed by adhesion and blistering is costly and difficult and quite often the only solution is complete removal and replacement.

Approach: Conduct laboratory tests to determine what parameters affect the adhesion of base sheet to substrate or interply adhesion. These tests would investigate such phenomena as moisture content, amount and composition of separator material, and possibly the compatibility of felt saturant, felt coating, separator and the various types of roofing asphalts used in such roofing systems. On the basis of these tests it may be possible to outline field inspection procedures or field tests of materials that would eliminate the adhesion problem. Field inspections of known roof adhesion failures would also be a part of this project so that laboratory experience and field data could be compared.

Estimated Cost: 2 years at $35,00/year

LFSkoda/gb 10-16-70

APPENDIX IV

A Proposal for Roofing Research
(Research Grant - Owens-Corning Fiberglas Corp.)

Background

Membrane roofing systems have been a source of serious and costly problems for the manufacturer, applier and consumer. The problems associated with membrane failure can be traced to a number of sources including, among others, material, design and application deficiencies. Since a roofing membrane is always used as part of an assembly of components such as the roof deck, vapor barrier and thermal insulation, the contribution of these components, acting alone or in concert with others, are important considerations to the performance of the roof membrane. In fact, the engineering properties of the membrane which ultimately determine performance should be considered in terms of other factors including compatibility with other subassembly components, susceptibility to environmental change (time, temperature and moisture), manufacturing techniques, design considerations and construction practices. Further, the abuse and misuse, which roofing systems are subjected to, have significant impact on performance under service conditions. Experience with the performance of membrane roofing has indicated wide variance in performance of various types of membranes in various climates. There is not sufficient evidence to indicate why some roof membranes perform as intended while others exhibit premature failure.

In order to predict the performance of membrane roofings under service conditions, meaningful criteria must be established. Further, test methods must be developed to obtain data to evaluate roofing membranes against criteria to be established.

Facilities for Roofing Research at NBS

Uniquely, the Building Research Division has a multi-disciplinary team available to aggressively conduct a roofing research program. The team consists of research engineers, chemists, materials technologists and others who have a considerable background in all phases of roofing technology and performance. The team members are equally at home in the laboratory and in conducting on-site investigations. The team is supported by the modern laboratory facilities equipped with weatherometers, load-strain testers, thermal mechanical analyzers and the like. Further, rather large scale experimental work can be conducted in various environmental chambers which are available at NBS. The largest is capable of enclosing a full structure. Temperatures ranging from -50°F to about 150°F can be obtained in the chambers. In addition, the Building Research Division has a network of eight outdoor exposure sites representing the various climates of the North American continent. These sites complement the laboratory facilities to study the climatic effects on performance of membrane roofing.

Objectives

The broad objective of the research is to establish meaningful performance criteria for membrane roofing.

Specifically, the objectives include the development of techniques to measure stresses which are developed in the roofing membrane. The sources of stress may be internal, such as moisture and thermal effects within the roof system or they may be external to the membrane, such as deck deflection and movement, impact, traffic and ice effects.

Further objectives are to provide data on probable stresses which may occur in various roof constructions and climates; to select or develop appropriate test methods which relate to stress resistance; to suggest criteria which can be incorporated into specifications for roof membrane designs, based on the analysis of data developed from the preceding steps.

Approach

The initial phase of the study will be concerned with a survey of both published and unpublished literature. Field investigations will be made to identify and quantify, where possible, the natural and other forces which act alone or in combination with other forces on membrane roofing systems to cause problems. Such field investigations will be conducted when brought to our attention by sponsors or from other sources. Particular emphasis will be placed on those roofing systems which have exhibited unique problems as well as those employing innovative materials in their construction. Test cuts will be made where deemed desirable and practicable. Test cuts will be evaluated at NBS and pertinent properties will be measured in the laboratory test program.

Concurrently, the laboratory phase of the program will be initiated and conducted to measure the pertinent properties of selected roofing membranes. Specifically, two approaches will be made. A selected small number (perhaps 3) of relatively large size (10' x 10' or greater) complete roofing systems (deck, insulation and membrane) will be constructed in an environmental chamber and various properties measured as the environment is changed and cycled. Further, the effects of superimposed forces originating internally or externally as ice, impact, building movement, foot traffic, etc., will be measured as required. The second approach will be to measure certain engineering and rheological properties of rather large numbers of small-scale specimens of roofing membranes representative of past, present, and future state-of-the-art of roofing field practice. A correlation among small-scale, large-scale testing, and observed or experienced performance in service will be made to arrive at the ultimate objective of performance criteria for built-up membranes.

Administration

The research will be conducted at the National Bureau of Standards with coordination through a project coordinator appointed by the sponsor. Periodic meetings will be held with the sponsors at NBS or Owens-Corning Technical Center, Granville, Ohio, as required. Reports of progress will be prepared quarterly. A NBS Report will be prepared at the conclusion of the project.

Duration: 2 years

Effort:

Funding

	Owens-Corning Fiberglas	National Bureau of Standards
FY1971 3 man years	$45,000	$40,000
FY1972 3 man years	$45,000	45,000
	$90,000	$85,000

TOTAL $175,000