EPDM Roof System Performance: An Update of Historical Warranty Service Costs

By James L. Hoff

FOREWORD

This paper provides a five-year update of the article, "EPDM Re-Roofing Versus Recover: A Comparison of Historical Maintenance Costs," originally published in Interface *in July 1998.*

INTRODUCTION

One of the most important steps in roof design involves selecting the best roof system for specific building conditions and building owner needs. In order to make the optimum selection, the designer must evaluate the costs and benefits of the many options available. While initial costs of roofing systems can be calculated with reasonable accuracy, it is much more difficult to accurately calculate the longer term warranty service and maintenance costs for different roofing systems. In order to make the best decision, the designer needs statistically accurate and reliable information based on actual historical performance of roofing systems.

The warranty service records of roofing manufacturers offer an interesting opportunity to expand the industry's understanding of roof system performance. Because warranty records typically include thousands of roofs covering millions of square feet, an analysis of the information contained in these records may be more statistically reliable than information gathered from limited sources. Because warranty service records also identify when a roof was installed and when warranty service was performed, they can provide an accurate chronology of roof performance. Finally, because warranty records provide the actual cost of any roof service performed, roof performance can be analyzed from an economic perspective.

THE ROOF SERVICE DATABASE

The database used in this study is significant both in size and scope. In regard to size, the database covers over three billion square feet of EPDM roofs installed on over one hundred fifty thousand roofs from 1982 to the present. Regarding the scope of detail provided in the database, the file for each roof contains extensive background information, including:

1. Construction type (new construction/re-roof/recover)
2. System type (ballasted/adhered/mechanically attached)
3. Geographic location (city/state or province)
4. Installing contractor (identification and current license status)
5. Warranty information (date completed/warranty term)

Because all roofs received a material and workmanship warranty, the database also contains detailed information regarding the timing, cost, and type of service performed or authorized by the manufacturer during the warranty period. The typical warranty period of the majority of roofs in the database is ten years, and the service records for each roof identify the cost and date of all service expenditures made by the manufacturer during this period. These expenditures include both emergency leak calls as well as more comprehensive repairs when necessary. In addition, each service activity is "coded" based on the principal roof system component that required service, allowing for a detailed analysis of the causes of service expense.

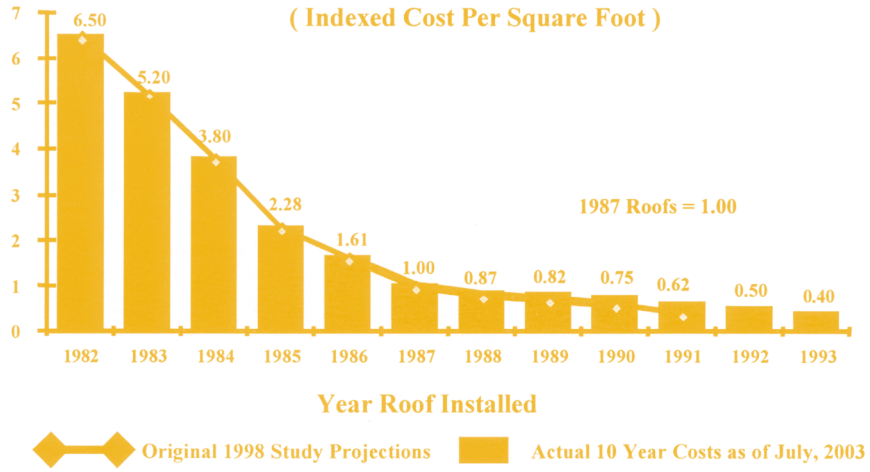
Given the level of detail available in the database, a number of trends can be analyzed, including the relative performance of roofs over time, the average frequency and timing of warranty service activities, and the comparative performance of different roof systems, components, and construction types.

DEFINITIONS AND METHODOLOGY

1. Historical warranty service cost is defined as the manufacturer's actual recorded spending during a specified period of service. For this study, costs are expressed as actual spending during each year of roof service following the initial installation.
2. Warranty service costs for any given segment of the database are divided by the total installed surface area of that segment, in order to allow for comparison between different segments of the database. As a consequence, the annual unit warranty service costs can be compared for any year.
3. In order to adjust for inflation, spending is stated in constant units, using 1982 as base year and adjusting each year based on the U.S. National GDP Deflator as calculated by the United States Bureau of Labor Statistics.
4. In order to maintain the confidentiality of the manufacturer's actual dollar costs in the database, warranty service costs are indexed against a baseline year.

Chart 1

EPDM Warranty Service Costs:
First Ten Years of Service
(Indexed Cost Per Square Foot)



EPDM ROOF SYSTEM PERFORMANCE: HISTORICAL TRENDS

Overall EPDM Warranty Service Cost Trends

At least ten years of actual historical warranty service costs are now available for all roofs installed in 1993 or earlier. *Chart 1* illustrates the overall change in warranty service spending during the first ten years of service for EPDM roofs installed each year from 1982 to 1993. As illustrated by the chart, unit warranty service costs declined 85% from 1982 to 1987. As will be discussed later in this paper, the significant drop in costs is most likely attributable to changes in product technology introduced during those years. Although the improvement trend begins to flatten out slightly from 1987 through 1993, cost reductions continue each year, and even these smaller incremental improvements account for another 60% reduction in warranty service cost.

It should be noted that when this study was first published in 1998, complete historical data were available only for the first five years of service for many of these roofs. As a consequence, the ten-year warranty service costs were estimated by applying regression analysis to the five-year trends available at that time. Five years later, it is very gratifying to report that the actual ten-year trends indeed follow the 1998 prediction. In order to demonstrate the closeness between the 1998 projections and actual results today, a line indicating the original projection has been added to *Chart 1*. It should be noted that any slight differences in the projected and actual cost are statistically insignificant at a 99.5% level of reliability.

Warranty Service Costs by Component

Chart 2 provides a breakdown of ten-year costs by the type of component requiring warranty service. For this study, components were divided into three broad categories: 1) field seams; 2) perimeter flashings, such as base tie-ins, edge metal flashings, and terminations; and 3) other components, including curbs, penetrations, and membrane attachment. During the period from 1982 to 1993, warranty service costs for both field seams and perimeter flashings improved significantly. The trends in this chart appear to reinforce the commonly held opinion that much of the improvement in EPDM system performance is due to changes in seaming and attachment technology. Costs associated with field seams and perimeter flashings have declined 92% and 95%, respectively. It should be noted that this improvement coincides with the introduction of several important component technologies by the roofing manufacturer:

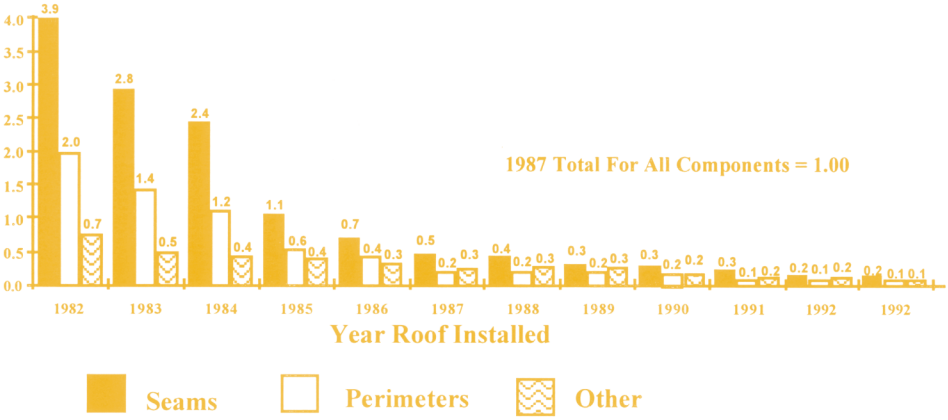
Year of Intro:	Technology:
1985 -1986	Butyl-based splice adhesive replaces Neoprene-based adhesive.
1985 - 1986	EPDM-based wall flashings replace Neoprene-based flashings.
1987 - 1988	Tape laminates replace adhesive seams at roof edges and battens.
1988 - 1989	Metal battens and screw fasteners replace wood nailers and nails.
1991 - 1992	Reinforced perimeter fastening strips introduced.
1992 - 1993	Seam tape with high-solids primer replaces seam adhesive.

Warranty Service Costs by System Type

Chart 3 provides a breakdown of ten-year costs by type of EPDM roof system. For this study, EPDM systems are divided into three major categories: 1) ballasted, 2) fully adhered, and 3) mechanically attached. The chart clearly illustrates the relative performance of these three basic system types has also changed

Chart 2

EPDM Warranty Service Costs by Key Component
(First Ten Years of Service / Indexed Cost Per Square Foot)



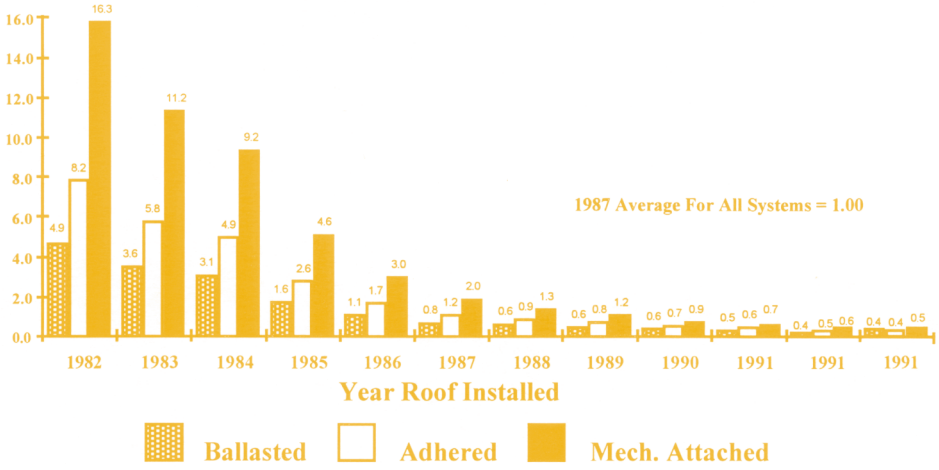
significantly over time. While both mechanically attached and fully adhered roofs under performed ballasted roofs in the early years of the database, all three systems now provide almost identical performance. This performance undoubtedly is related to previously identified improvements in field seams as well as the relative number of seams required for each of these systems.

While ballasted roofing systems typically use EPDM membrane panels up to 50 feet wide by 100 feet long, fully adhered and mechanically attached systems frequently use smaller roof panels requiring more field seams. Given the relatively high warranty service costs associated with field seams in the early years of the database, it is reasonable to infer that roofs with a large number of field seams will be affected the most by seam performance. As the performance of field seams has improved, however, the number of seams in the roofing system has become a less critical factor, thus narrowing differences in system performance.

Chart 3

EPDM Warranty Service Costs by System Type

(First Ten Years of Service / Indexed Cost Per Square Foot)



Ten-Year Warranty Service Costs Versus Initial Installed Costs

Although the cost indexing employed in this study allows for comparison of warranty service costs over time, this indexing provides no immediate comparison to the initial cost of the roof. However, using a similar indexing approach, the estimated initial cost of the roofs in the database can be compared to the actual ten-year warranty service costs. Based on cost data derived from a nationally published construction cost estimating workbook, indexed installation costs were calculated for several types of EPDM systems in the database[1]. As illustrated in *Chart 4*, warranty service costs for EPDM roofing systems account for a very small percentage of total roof costs, even for systems installed in the early 1980s. While ten-year warranty service costs for EPDM roofs installed in 1982 amounted to less than 10% of the original installed cost, the same ten-year warranty service cost for EPDM roofs installed in 1993 is barely more than 1% of the original installed cost.

EPDM Recover Versus Re-roofing

One of the most important steps in designing a roofing system for an existing building involves the evaluation of the existing roof. Even before the specification for a new roof system can be developed, the designer must first decide whether to remove or retain the existing roof. Although it is generally acknowledged that removal of the existing roof system is the most conservative design practice, environmental and economic concerns make complete tear-off increasingly difficult. Before deciding whether to tear off the existing roof, the designer must analyze the costs and benefits of complete removal.

Chart 5 shows the ten-year performance trend for two approaches to roof replacement: 1) re-roof, or the tear-off of the existing roof and installation of a new roof, and 2) recover, or the installation of a new roof directly over the existing roof. For comparison purposes, the chart also provides similar information for roofs incorporated into new construction work. Although the ten-year warranty service costs for new construction and re-roofing projects installed during the early 1980s were almost equal, the costs of recover projects in the early 1980s were significantly higher than either new construction or re-roof warranty service costs. However, this difference in costs narrows each year. By

Chart 4

EPDM Warranty Service Costs: New / Re-Roof / Re-Cover

(First Ten Years of Service / Indexed Cost Per Square Foot)

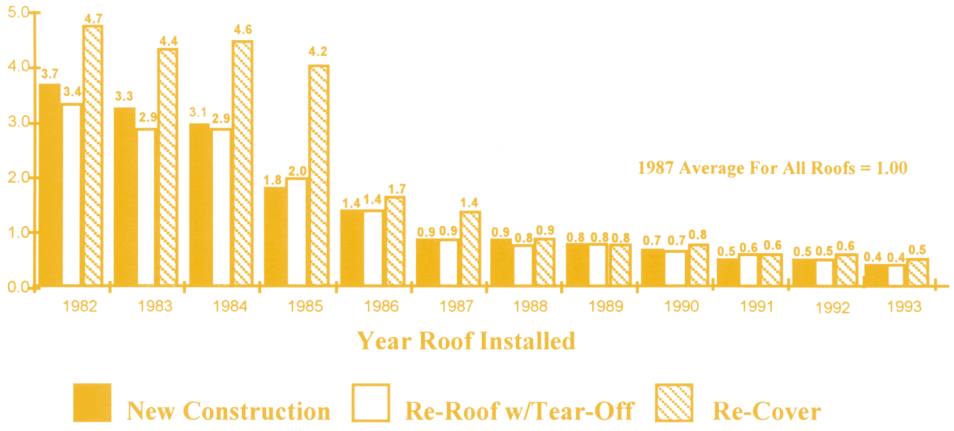
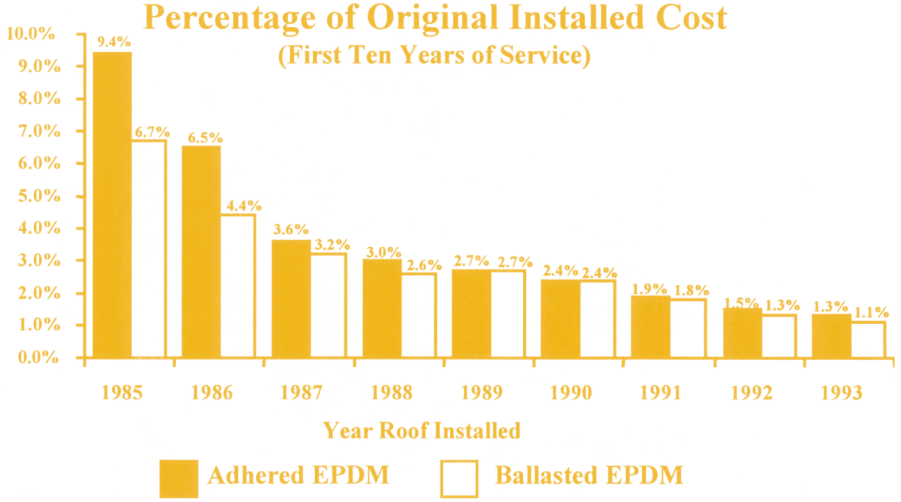


Chart 5

EPDM Warranty Service Costs as a Percentage of Original Installed Cost
(First Ten Years of Service)



Note: Installed cost derived from *2002 National Construction Estimator* (Craftsman Books) and adjusted annually for inflation.Costs based on the application of a ten-year warranted EPDM roofing system installed over an exposed metal or concrete roof deck and a minimum R20 polyisocyanurate roof insulation.

offer superior service for many years beyond the ten years of this study.

It also appears this improvement has been most significant for EPDM recover systems. Given the escalating costs associated with roof tear-off and the ever-present financial constraints on building owners, a roofing designer certainly can take comfort knowing that a properly selected EPDM recover system may provide an acceptable service life at a reasonable cost. Of course, the data presented in this article should not be used to endorse recovers in all situations. Existing roofs that are saturated with water or seriously deteriorated are obviously candidates for a complete tear-off. However, the data in this study clearly suggest that when an EPDM recover system is properly installed over a suitable existing roof, it will provide many years of acceptable service with minimal warranty service expense. ■

1988, the gap in warranty service cost between recover and re-roofing has virtually disappeared. In fact, for roofs installed between 1988 and 1993, the difference in ten-year repair costs between EPDM recover and re-roofing is statistically insignificant.

What caused the performance difference between EPDM re-roofing and recover in the early 1980s, and why did this gap close so dramatically by the end of the decade? In order to better understand this trend, we must look back at the performance trends of the basic design and material components of EPDM roofing systems. Although improvements in components such as field seams and perimeter attachments obviously reduced warranty service costs for both re-roofing and recover, it would appear the effect on recover applications has been more favorable. Undoubtedly, much of this improvement can be attributed to the elimination of Neoprene-based seam adhesives, which were commonly recognized to be more sensitive to moisture drive than butyl or EPDM-based adhesives and seam tapes. Assuming a typical recover project installed over an existing roof may contain more latent moisture than a roof installed over a complete tear-off, improvement in the moisture resistance of any component will obviously contribute to lower service costs. Improvements in perimeter securement also may have contributed to the relative improvement of recover systems, since attachment to hidden substrates, which is typical practice for recover projects, is obviously more difficult than attachment to substrates that have been fully exposed by the removal of an existing roof.

EPDM ROOF SYSTEM PERFORMANCE: SUMMARY OF FINDINGS

Based on the warranty records of the three billion square feet of EPDM roofs in this study, EPDM roofing performance has improved dramatically over the past 20 years. In fact, the improvement in performance now makes the cost of servicing an EPDM roof for ten years almost negligible. Given the extremely low cost of warranty service through the first ten years of service, it is also likely that the great majority of these roofs will continue to

Footnote:

1. Installed cost data derived from *2002 National Construction Estimator* (Craftsman Books). Installed cost is based on the application of a ten-year warranted EPDM roofing system installed over an exposed metal or concrete roof deck and a minimum R-20 polyisocyanurate roof insulation. Indexed unit costs are adjusted for inflation during the period 1982 through 1993 based on the U.S. National GDP Deflator as published by the U.S. Bureau of Labor Statistics. Indexed unit costs are available only for ballasted and fully adhered systems. Because mechanically attached EPDM systems may vary significantly in system design, it was not possible to develop a reliable unit cost using the general system descriptions in the *National Construction Estimator.*

About the Author

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Jim Hoff (hoffjames@firestonebp.com) has served in a variety of technical and management roles in the construction industry for over twenty-five years. Currently, Hoff is vice president of marketing for Firestone Building Products Company and serves as chairman of the board of the Polyisocyanurate Insulation Manufacturers Association (PIMA). Hoff received an A.A.S. in architectural technology from Indiana Vocational Technical College, a B.A. in psychology from Indiana University, a M.S. in management from Indiana Wesleyan University, and currently is completing his doctoral dissertation for a D.B.A. in management from the University of Sarasota.