Real results

A case study investigates the benefits of a proactive approach to roof system maintenance

by Dane Bradford

In his book, *Hocus Pocus*, Kurt Vonnegut states, "Another flaw in the human character is that everybody wants to build and nobody wants to do maintenance." This statement often is frustratingly true in the roofing industry. Roofing contractors and consultants who sell formal roof system maintenance programs often encounter an "out of sight, out of mind" mentality when trying to convince building owners and managers to appreciate the value of maintaining roof assets. But some empirical data based on real-world situations demonstrate how valuable a proactive approach to maintenance can be.

How we do it

Each time my company inspects or surveys a roof, the cost of the inspection is added to the asset's value. Roof surveys are performed on a schedule that provides an owner with a list of necessary repairs and maintenance. Surveys typically are performed every other year, and a report of findings is provided so recommended work easily can be located and repairs can be made. The survey reports include work anticipated during the years when surveys are not performed, so no extended period passes without some attention to the roof. Interim roof system inspections are performed to ensure nonessential work is performed, such as cleaning drains and removing debris from the roof surface.

Each time we repair or maintain a roof, the cost of that activity also is added to the asset value. Repairs can be as minimal as applying a few feet of caulking or as large as removing and replacing base flashings on an entire roof section. The fundamental concept is to

A COMPARISON OF ROOF SYSTEM MAINTENANCE

BUILDING A							BUILDING B						
YEAR		SQUARE FEET	COST/ SQUARE FOOT	TOTAL	MAINTENANCE (BEGINS YEAR 2)	TOTAL INVESTMENT	COST OF OWNERSHIP/YR	YEAR		SQUARE FEET	COST/ SQUARE FOOT	TOTAL	MAINTENANCE (BEGINS YEAR 8)	TOTAL INVESTMENT	COST OF OWNERSHIP/YR
1990	NEW ROOF INSTALLATION	450,000	$7.83	$3,523,500.00		$3,523,500.00	$3,523,500.00	1990	NEW ROOF INSTALLATION	300,000	$7.36	$2,208,000.00		$2,208,000.00	$2,208,000.00
1992	INITIAL SURVEY	450,000	$0.0400	$18,000.00	$18,000.00	$3,541,500.00		1992							
	MAINTENANCE	450,000	$0.0185	$8,334.00	$26,334.00	$3,549,834.00	$1,774,917.00								
1993	MAINTENANCE	450,000	$0.01 13	$5,085.00	$31,419.00	$3,554,919.00	$1,184,973.00	1993							
1994	SURVEY	450,000	$0.0300	$13,500.00	$44,919.00			1994							
	MAINTENANCE	450,000	$0.0166	$7,456.50	$52,375.50	$3,575,875.50	$893,968.88								
1995	MAINTENANCE	450,000	$0.0120	$5,400.00	$57,775.50	$3,581,275.50	$716,255.10	1995							
1996	SURVEY	450,000	$0.0300	$13,500.00	$71,275.50			1996							
	MAINTENANCE	450,000	$0.0092	$4,1 17.50	$75,393.00	$3,598,893.00	$599,815.50								
1997	MAINTENANCE	450,000	$0.0230	$10,350.00	$85,743.00	$3,609,243.00	$515,606.14	1997							
1998	SURVEY	450,000	$0.0300	$13,500.00	$99,243.00			1998	SURVEY	300,000	$0.0400	$12,000.00	$12,000.00	$2,220,000.00	
	MAINTENANCE	450,000	$0.0181	$8,158.50	$107,401.50	$3,630,901.50	$453,862.69		MAINTENANCE	300,000	$0.2530	$75,900.00	$87,900.00	$2,307,900.00	$288,487.50
1999	MAINTENANCE	450,000	$0.0031	$1,395.00	$108,796.50	$3,632,296.50	$403,588.50	1999	MAINTENANCE	300,000	$0.1550	$46,500.00	$134,400.00	$2,354,400.00	$261,600.00
2000	SURVEY	450,000	$0.0350	$15,750.00	$124,546.50			2000	SURVEY	300,000	$0.0350	$10,500.00	$144,900.00	$2,364,900.00	
	MAINTENANCE	450,000	$0.0235	$10,575.00	$135,121.50	$3,658,621.50	$365,862.15		MAINTENANCE	300,000	$0.0934	$28,020.00	$172,920.00	$2,403,420.00	$240,342.00
2001	SURVEY	450,000	$0.0350	$15,750.00	$150,871.50			2001	SURVEY	300,000	$0.0350	$10,500.00	$183,420.00	$2,413,920.00	
	MAINTENANCE	450,000	$0.0254	$11,430.00	$162,301.50	$3,685,801.50	$335,072.86		MAINTENANCE	300,000	$0.1742	$52,260.00	$235,680.00	$2,476,680.00	$225,152.73
2002	MAINTENANCE	450,000	$0.0453	$20,385.00	$182,686.50	$3,706,186.50	$308,848.88	2002	MAINTENANCE	300,000	$0.1778	$53,340.00	$289,020.00	$2,530,020.00	$210,835.00
2003	SURVEY	450,000	$0.0370	$16,650.00	$199,336.50			2003	SURVEY	300,000	$0.0370	$11,100.00	$300,120.00	$2,541,120.00	
	MAINTENANCE	450,000	$0.0251	$11,295.00	$210,631.50	$3,734,131.50	$287,240.88		MAINTENANCE	300,000	$0.3100	$93,000.00	$393,120.00	$2,645,220.00	$203,478.46
2004	MAINTENANCE	450,000	$0.0240	$10,800.00	$221,431.50	$3,744,931.50	$267,495.11	2004	MAINTENANCE	300,000	$0.0676	$20,280.00	$413,400.00	$2,665,500.00	$190,392.86
2005	SURVEY	450,000	$0.0400	$18,000.00	$239,431.50			2005	REROOF						
	MAINTENANCE	450,000	$0.0300	$13,500.00	$252,931.50	$3,776,431.50	$251,762.10		CONST.	300,000	$11.09	$3,327,000.00			
									DESIGN		$55,000.00	$55,000.00			
									Q/C		$97,500.00	$97,500.00			
2006	MAINTENANCE	450,000	$0.0562	$25,290.00	$278,221.50	$3,801,721.50	$237,607.59	2006	TOTAL REROOF			$3,479,500.00		$6,145,000.00	$361,470.59
2007	SURVEY	450,000	$0.0400	$18,000.00	$296,221.50			2007	SURVEY	300,000	$0.0400	$12,000.00	$425,400.00	$6,157,000.00	
	MAINTENANCE	450,000	$0.0370	$16,650.00	$312,871.50	$3,836,371.50	$225,668.91		MAINTENANCE	300,000	$0.0270	$8,100.00	$433,500.00	$6,177,100.00	$363,358.82
2008	MAINTENANCE	450,000	$0.0320	$14,400.00	$327,271.50	$3,850,771.50	$213,931.75	2008	MAINTENANCE	300,000	$0.0312	$9,360.00	$442,860.00	$6,186,460.00	$343,692.22
2009	SURVEY	450,000	$0.0450	$20,250.00	$347,521.50			2009	SURVEY	300,000	$0.0450	$13,500.00	$456,360.00	$6,199,960.00	
	MAINTENANCE	450,000	$0.0453	$20,385.00	$367,906.50	$3,891,406.50	$204,810.87		MAINTENANCE	300,000	$0.0232	$6,960.00	$463,320.00	$6,220,420.00	$327,390.53
2010	MAINTENANCE	450,000	$0.0351	$15,795.00	$383,701.50	$3,907,201.50	$195,360.08	2010	MAINTENANCE	300,000	$0.0333	$9,990.00	$473,310.00	$6,230,410.00	
2011	SURVEY	450,000	$0.0450	$20,250.00	$403,951.50			2011	SURVEY	300,000	$0.0450	$13,500.00	$486,810.00	$6,243,910.00	
	MAINTENANCE	450,000	$0.0353	$15,885.00	$419,836.50	$3,943,336.50	$187,777.93		MAINTENANCE	300,000	$0.0387	$11,610.00	$498,420.00	$6,269,020.00	$298,524.76
2012	MAINTENANCE	450,000	$0.0412	$18,540.00	$438,376.50	$3,961,876.50	$180,085.30	2012	MAINTENANCE	300,000	$0.0390	$11,700.00	$510,120.00	$6,280,720.00	$285,487.27
2013	SURVEY	450,000	$0.0450	$20,250.00	$458,626.50			2013	SURVEY	300,000	$0.0450	$13,500.00	$523,620.00	$6,294,220.00	
	MAINTENANCE	450,000	$0.0600	$27,000.00	$485,626.50	$4,009,126.50	$174,309.85		MAINTENANCE	300,000	$0.0367	$11,010.00	$534,630.00	$6,318,730.00	$274,727.39
2014	SURVEY	450,000	$0.0450	$20,250.00	$505,876.50			2014	MAINTENANCE	300,000	$0.0310	$9,294.00	$543,924.00	$6,328,024.00	$263,667.67
	MAINTENANCE	450,000	$0.0648	$29,151.00	$535,027.50	$4,058,527.50	$169,105.31								
2015	SURVEY	450,000	$0.0450	$20,250.00	$555,277.50			2015	SURVEY	300,000	$0.0450	$13,500.00	$557,424.00	$6,341,524.00	
	MAINTENANCE	450,000	$0.0851	$38,299.50	$593,577.00	$4,117,077.00	$164,683.08		MAINTENANCE	300,000	$0.0478	$14,340.00	$571,764.00	$6,369,364.00	$254,774.56

NO WORK PERFORMED DURING THIS PERIOD

A comparison of maintenance schedules for two identical roofs

present a proactive approach in which we fix small repair items before they deteriorate enough to allow moisture into a structure.

And when an owner reroofs a building, he accrues the costs of reroofing. These include design fees, cost of installing the new roof and, if applicable, cost of quality assurance during the construction process.

The cost of ownership

As the life of a roof asset progresses, costs accumulate, and to establish a cost of ownership at any time during the life of an asset, you simply divide the total accumulated costs for the asset by the number of years the asset has been in existence to find the cost per year of ownership.

But one great difficulty when proving the value proposition of maintenance is finding buildings or facilities located in similar climatic conditions and comparable in roof system type, age and other important data points that allow a close comparison of ultimate cost of roof ownership.

When comparing the cost of ownership, there needs to be a method to define and collect costs that will be meaningful to the owner in the final analysis. This presents a problem that has made this process difficult in the past. Life-cycle cost of roof ownership has been defined and redefined by various interested parties for years. Unfortunately, the more variables involved in the calculation, the more complicated it becomes to make the ultimate comparison.

The abstract of ASTM E917-05, "Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems," contains the statement: "The basic premise of the LCC [life-cycle cost] method is that to an investor or decision maker, all costs arising from an investment decision are potentially important to that decision, including future, as well as present, costs. Applied to buildings or building systems, the LCC encompasses all relevant costs during a designated study period, including the costs of designing, purchasing/leasing, constructing/installing, operating, maintaining, repairing, replacing and disposing of a particular building design or system."

This standard certainly can provide good life-cycle cost data for the ownership of one structure or component. However, the reality is that it has proved almost impossible to attain all the pertinent data collected in the same way for two similar structures during similar time periods to create a meaningful comparison. The one particularly difficult comparison factor in almost every situation is finding one building managed with a focus on long-term roof performance and another managed on the basis of Vonnegut's observation. Changes in ownership, management of roof assets and data-collection methods are just a few issues that, during a 10- to 15-year time period, could make a meaningful comparison impossible.

For the purpose of my comparison, I am going to take a relatively simplistic approach and use a minimum of data points that arguably are the most pertinent to a comparison of life-cycle cost of a roof. I will include the initial cost of roof construction in the calculation. In addition, the cost of roof system inspections or surveys will be included as will the cost of completed roof repairs and maintenance that result from any surveys or inspections. All costs related to reroofing—including design fees, construction costs and any related quality-control/quality-assurance activities—will be included.

Data

The following information is based on a comparison of two similar buildings of the same age and construction style on which my company performed inspections. The buildings are located in the northern Midwest in similar climatic conditions and have been owned by the same entity since they were built. The owner typically builds buildings with a focus on long-term ownership and tends to be concerned about maintaining the interior and exterior of his buildings. The building and facility managers are asked to budget for facility maintenance, but the owner allows for discretion in the way the money is spent. Although the expectation of maintaining a sound building envelope is communicated well to the facility directors, some do a better job than others of taking the initiative to ensure roofs perform well.

The roof system on each building is identical. The same architectural firm designed both buildings, and the overall style is similar. The buildings have insulated four-ply built-up roof systems with aggregate surfacing installed over steel decks. With few exceptions, detailing for the roof conditions is the same. Each building has the same interior building use. There is a large amount of rooftop traffic on both buildings during any given year, and service and installation of heating, ventilating and air-conditioning units and other rooftop units are common occurrences.

In the case of the two sample buildings, one facility manager was proactive concerning roof asset management from the start; the other was not. The facility manager at building A began having his roof surveyed shortly before the two-year roofing contractor's warranty expired. The items identified as needing attention immediately were addressed, and from each ensuing survey, a budget was developed to provide the needed funds in future years to handle preventive roof system maintenance and anticipated emergency repairs.

In the case of building B, the facility manager determined a new roof should not need to be maintained and money that would be spent on surveys and recommended repairs would be better spent in other ways. If the roof were to leak, it would be repaired immediately; however, the approach was not proactive. In 1998, eight years after the roof was installed, building B's facility manager

retired. During this eight-year period, the cost of emergency repairs was relatively high but not recorded. Because good data weren't provided for this, the emergency repair dollars for this roof during the eight-year period were not included in the calculation for emergency repairs.

In 1996, building B's new facility manager instituted a roof asset management program identical to that used on building A. It consisted of roof surveys every two years with a resulting proactive budgeting process for roofing needs. Roof system deficiencies identified as needing attention were handled as recommended. The cost of maintaining the roof was relatively high for the next several years as a result of the maintenance deferral during the first eight years and damage that resulted from rooftop traffic.

In 2005, building B was reroofed. Regularly scheduled maintenance and emergency repairs had not been able to keep pace with the damage and deterioration to the owner's satisfaction, and it was determined the roof would need to be replaced. The costs of design and full-time quality-control/quality-assurance during construction were added to construction costs. These accumulated expenditures then were added to the calculation of the ownership cost of building B's roof assets.

During the first 15 years, building A's roof was surveyed every two years and the needed repairs were completed each year. Budgets for maintenance and anticipated repairs were generated after each survey that would be earmarked for roofing work during the ensuing two-year period. Although the damage from rooftop traffic was similar in nature to damage on building B, the repairs were completed in most cases before water entry into the roof system and building began to have any serious effects. Small defects were repaired before they became big enough to affect building systems or disrupt interior activities.

Currently, both roofs are performing well. When reviewing the repair costs for building A, it is evident the owner has relatively level expenditures for roof system repair and maintenance. When anticipating future needs, my company estimates the roof on building A will begin to require more attention and higher expenditures during the next 10 years. It is anticipated the expenditures will increase, but there should not be a spike in those costs even as the inevitable reroofing nears, which, using historical information, we anticipate will occur sometime between 2015 and 2018. Because a roof asset management program is in place, the reroofing will come as a result of a planned, budgeted approach rather than a result of the owner being unable to address roof-related problems.

Costs of deferred maintenance can increase the cost of ownership

Findings

For the comparison of cost of ownership, I'd like to consider a time period of 25 years. By accumulating all the cost data—both real and projected—that will be expended on each roof during the time period, we will be able to determine the cost of ownership for both buildings. The buildings were constructed in 1990, so the data will be historical for the first 16 years and projected to the twenty-fifth year based on experience and estimates that result from managing these and other similar roofs.

The data in the figure illustrate the findings. During the 25 years the figure spans, building A has relatively stable and level maintenance expenditures and building B has none during the first eight years with relatively high repair costs for the following seven years. Building B was reroofed in 2005, and a proactive maintenance program was established that parallels that of building A. The projected cost pattern from that time to the future levels off and follows the same stable levels that have been evidenced with building A.

Calculations show some real differences for the two approaches to proactive maintenance. As we would predict, the deferred maintenance on building B, which added to the repair and maintenance costs and eventually led to premature reroofing of the building, makes a significant difference in the long-term carrying cost of owning the building.

The total maintenance cost for building A—without surveys and inspections—during the 25-year period is projected to be about $375,000, which translates to an average cost of 83 cents per square foot, or average of 3 cents per square foot per year. In the case of building B, during the 25-year time period the total is projected to be about $467,000, or $1.54 per square foot, or 6 cents per square foot per year on average.

For the 25 years, we see a projected cost of about $4.2 million for building A and $6.4 million for building B. This translates to an ownership cost of about $9.15 per square foot for building A, whereas with building B, the projection is $21.23 per square foot by the twenty-fifth year.

Better value

There are many methods to determine the value of roof system maintenance. Through the example, you can see the cost of deferring maintenance on a roof versus the value of embracing a program of proactive roof system maintenance. The cost of ownership of a roof asset appears in a side-by-side comparison to be significantly lower if a roof is maintained and repaired throughout its service life. In other words, the costs of deferred maintenance can increase the cost of ownership.

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