Life-cycle Cost Analysis

by Rich Boon

As the life-cycle cost study period is lengthened, there will be a shift to longer-lasting, lower-maintenance roofing systems.

Selection of a roofing system is often based on the lowest first cost. That cost is the bid price to install the specified system - a practice common in the roofing industry. However, it does not always result in the "best" roof. We assume that the specification and subsequent "low bid" installation is adequate to the needs of the building being protected. The potential for damages due to interruption of the building's activities or loss due to a failure of the roof is generally not directly considered by some designers.

We can upgrade this low bid system by upgrading the materials and systems specified and by holding the contractor to the highest workmanship standards of the industry. The first change involves conducting additional research to determine what constitutes an upgrade in materials or systems. To upgrade workmanship, limit the bid list and/or employ an outside quality assurance agency. Both steps will increase the cost of a project. The upgrading of the gage of metal used in counterflashing, or the addition of extra membrane plies, will increase first cost. The benefits of these upgrades may not be evident for years.

There are many ways to select a roofing system. As mentioned, one way is simply to go with first cost. For many, that is the only criterion that counts. This may result in the selection and installation of roofing systems that do not live up to expectations. This lowest first cost system may be the least expensive roof over its life, but the odds are, it won't be. How can we, as roofing professionals, prove to the financial decision makers that upgrades are desirable and justifiable?

Life-cycle Costing

Life-cycle cost analysis is the appropriate technique to examine the cost of a roof over a pre selected study period. This study should include all of the relevant costs associated with owning the roof. These include maintenance, cost of damage due to leaks, lost energy due to wet insulation, insurance premiums, and all other costs tied to the roof. When preparing to re-roof an existing facility, experience with the old roof will reveal defects that can be avoided the second time around. Justifying upgrades is not always easy.

Fortunately we have an ASTM standard practice for developing life-cycle costs for buildings and building components. This gives us standardized accounting and financial methodology. The standard is ASTM E-917, *Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems.* ASTM E-833 defines terms we as roofing professionals need to know.

One of these references reports that if repair costs could be reduced by only $1 per year, this has a value of $10-$12 at the time of construction. It also concluded that the value of reducing initial costs by $1 is only worth about 8 cents on a life cycle basis.

1. Two Techniques

ASTM E-119 provides two techniques to study options: (1) Present Value - what is the roof worth today, and (2) Annualized Cost - what is the roof going to cost on a year-after-year basis.

To determine the Present Value, all of the expenditures and salvage values for the roof are summed and expressed in common dollars. This includes any expenses that may affect the roofing system. Obviously many of these must be estimated. The better the estimate the easier it is to defend if questioned.

To determine the Annualized Cost, the Present Value determined above is converted to the projected annual costs over the study period.

2. Selecting a Study Period

The selection of an appropriate study period is important. The selection of the length of the study period should reflect the time frame of interest, whether that is an expected useful life of the building, or some other factor. All options must be compared using the same length of time in order for the Present Values to be comparable.

The study period might be based on the reasonable expectation of the economic life of the building, assuming the owner plans to stay in the building. If the building is going to be torn down in five years, the least expensive roof may be the best choice. However, there are many "temporary" buildings still in continuous use years after their design life has passed, so the rationale for selection of the basis should be clear.

3. Inflation

The ASTM E-917 method allows for the effect of inflation. If one cost item is expected to rise faster than the general rate of inflation (for example, the cost of energy) than an escalation factor can also be included in the analysis.

4. Discount Rate

Consistency in analysis requires that the value of a dollar be either set to today's dollars called constant dollars, or the value is current at the time of the expenditure.

5. Taxes

Except for governmental and nonprofit organizations, taxes are part of the equation. Depreciation is the rate that the roof may be written off against taxable income. It is an expense over time. The schedule for depreciation of capitalized roofs is set at 39 years by the tax code.

6. Cash Flow

Cost data for items expected to be expended over the roofs life must be anticipated. This includes costs associated with maintenance, repairs, and replacement if the product is not expected to last as long as the study period.

7. Constant vs. Current Dollars

Consistency in analysis require that the value, of a dollar be either set to today's dollars called constant dollars, or the value is current at the time of the expenditure.

The effects of income taxes can complicate the task. If the dollars are assumed to be current dollars then the income taxes are not difficult to calculate. If constant dollars are used then calculating income taxes play become more difficult.

Once a value is selected, it must be used consistently.

Setting Up the Model

A sample may help illustrate the technique: the roofing project will be a garage for storing fleet cars and a new roof is needed. The bids come in for a variety of systems. The lowest bid is a liquid-applied polymeric coating system reinforced with a polyester scrim. The warranty for the proposed system is five years. The highest bid is to install sloped structural members and a standing seam metal system. Between is a bid for a thermoplastic single-ply membrane. What do you do?

System	Bid	Warranty
Liquid	$4, 750	5
Thermoplastic	$9,000	10
Metal	$13, 500	20

On a first cost basis, the liquid-applied is the best system. The metal salesperson says that his is the least expensive. But which is correct?

The way the metal person supports his statement is to simply divide the price by the warranty length as follows:

System	Bid	Warranty	Cost/Year
Liquid	$4,750	5	$950
Thermoplastic	$9,000	10	$900
Metal	$13,500	20	$675

Using the logic of the metal company, the most expensive roof is the least expensive. This table assumes that there is no maintenance required on any of the proposed systems and that they will not leak. It also ties length of warranty to the. roof's life span. These are not necessarily the most valid assumptions that could be made.
This analysis also does not consider the time value of the money.
For a short study period of seven years, the cheapest roof is the most cost effective.

Study Period - Seven Years

System	Net PV
Liquid	$6,869
Thermoplastic	$7,117
Metal	$8,045

As the study period is lengthened, there will be a shift to longer-lasting, lower-maintenance systems.
A problem that needs to be addressed is a rational estimate of how long this roof will last. It might be expected to last as long as the warranty, but this is not always the case.

The models here used the following assumptions. (1) The roof will leak before it is replaced. If this was not so, it is unlikely that it would be replaced: (2) The metal roof will require virtually no maintenance, partially attributable to the positive slope. The slope discourages people from walking on it; and, (3) After the second roof is put on the building, everything must come off before a third roof can be installed. This will have a greater impact if the roof is replaced regularly.

Maintenance Example

There are different combinations of factors that can be included to describe a particular situation. The creation of a model allows for changes to be made and then results compared. This was done by the Roofing Industry Educational Institute for its Roof Asset Management course. The model used compared different levels of maintenance. The full model compared three options. For this article only, the first two will be shown.

The options for rooftop maintenance include "do nothing" and "do the industry recommended minimums." This includes twice yearly inspections and inspections after any major storms. Items discovered during the survey are repaired as needed. In the "do nothing" model, leaks require calling in a professional roofing contractor to find and fix the leaks.

The RIEI example proves there is a provable financial advantage to spending money on preventative maintenance. Every materials manufacturer should provide specific information regarding recommended maintenance. This information can be converted into a cost model to be used in a life cycle analysis.

Conclusion

Life-cycle cost information is being Used by the engineering profession for making decisions between systems and products. The roofing industry has not used these techniques until very recently. ***(Bluestone has been using these techniques since 1982!!)*** Once the basic technique is mastered, you can better interpret life-cycle presentations by others.

To improve the quality of an analysis, more realistic life expectancies for various types of roofing materials and systems need to be found. The best source of this data would he from the owner's own data base, another reason to manage roofs as part of an organized roof management program.

Life-cycle costing should be used to make purchasing decisions. This is a technique that is explainable and understandable to the financial community. If the person that signs the checks understands why and how a given course of action is decided it is going to be easier to get approval to follow that course of action.