The Role of Service Life Prediction In Sustainability Determinations

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INTRODUCTION

Sustainability calculations are based on assumptions about the energy required to produce, transport place in-service items. A critical component of these calculations is the expected service life of the material, component or system. Estimates of the actual in-service performance are not based on scientifically validated methods or procedures. The resulting estimates have a significant uncertainty because they are based on past performance or best guess estimates.

This paper will detail the economic outcomes of typical choices on a new construction building joint sealant job based on available choices. Following this examination, this paper will detail the barriers and progress toward achieving a scientifically validated prediction of the in-service performance.

Building details for Building Joint Sealant Job

To examine the sensitivity of sustainability calculations to variation in service life prediction, it is useful to create a typical case study. In our case study, a firm with 90 people is seeking a new headquarters. This new building is ~40k m^3 with 102 m^2 (50k ft^2) of wall. The face of each side of the cube is 34 m (112 ft).

In this new eight story building, there are individual modules that have a stone facing below the widow and above with a window in the middle. The windows are 183 cm tall by 152.4 cm wide (6 ft. x 5ft.). Above and below these windows are a stone facing 99 cm tall x 152.4 cm wide (3.25 ft. by 5ft). This gives a typical floor separation of 411 cm (13.5 ft). For each module, there is 17 m of joint to be sealed. Because each module shares one face with the adjoining module, there is actually 11 m (36.5 ft) of sealant bead for each module which has 6.2 m^2 (67.5 ft^2) of wall. Since there is 102 m^2 (50k ft^2) of wall in the building, and for each 6.2 m^2 of wall requires 11m of building joint sealant, the building will need 8.2k m (27k ft) of building joint sealant. Assuming that the sealant bead is 1.9 cm (0.75 inches) deep and 1.6 cm (5/8 inch) wide, typical sealant cartridge of 305 ml will be able to seal ~0.8 m (assuming 20% waste). In order to seal this building, 6102 cartridges will be required. It is at this point the critical decisions that will affect sustainability come into play. Commercial building joint sealant sells in a range from \$2-\$7 per cartridge. So the critical decision is how much to spend on materials, a minimum of \$12k for the least expensive material or \$43k for the most expensive.

Calculation of Net Present Expense

During construction, there is an intense focus on minimizing cost. Without knowledge of the in-service performance, the two building joint sealants appear equivalent. Do they result in the same life cycle cost? To examine this question, a net present value model is created. The labor cost is fixed for a new installation at \$4/30.5 cm (1 ft) of building joint sealant. If we need to reseal the leaking building at a later time, this would be \$8/30.5cm (1ft). This gives us a fixed labor cost of \$110k for the new building and \$220k to reseal the building at a later date. With the labor cost and the materials costs in hand, the calculation of the net present expense to keep the building sealed for 25 years can be calculated. The calculation is based on all the expenses required to keep the building sealed over the 25 year time period. If the sealant fails at some point, an increment of labor and materials will be included. Additionally, a 6% discount rate is included. At the end of the 25 year period, there may be some additional life left in the sealant. To account for this the amortized annual cost for the all of remaining years is calculated as a net present value in year 25, again with a discount rate of 6%.

To understand how this calculation was done, let us assume a six year durability period and \$2/30cm (ft). The initial expense of \$122,040 is amortized over the six years to an annual expense of \$24,818. In year seven, the building leaks and the sealant must be replaced. The cost of that resealing is \$231,876 with \$12k of materials and \$220k of labor. This cost is amortized over the next six years with an annual expense of \$47,155/yr. In years 13,19, and 25 this procedure is repeated again. So for years 7-25, the annual expense is \$47,155 yr or (\$492,963) At the end of the 25 years period, there are still five years of life left in the sealant. This value is accounted for by five annual payments of \$47,155 brought back to year 25 as a lump sum (\$198,633 in year 25). By including the value (\$198,633 in year 25) with the year one expense (\$492,963) the net present expense of \$449,300 is determined. Another way to think about this figure is this is the size of the loan that would need to be taken out in year 1 to keep the building sealed for 25 years with a six year durability, and \$2/30 cm material cost.

This calculation is repeated for both the \$2/30cm and \$7/30 cm materials cost for years of durability from 2 to 20 years in Figure 1. In this figure, the high crossbar represents the Net Present Expense for \$7/30cm material and the lower crossbar is the \$2/30 cm material. In this figure, the materials cost becomes much less important as the number of years of durability increase. The really expensive material will last less than 10 years. Field studies have shown that 50% of sealant fails within 10 years and 95% fails by 20 years, thus defining the parameters of our study.

Summary

From figure 1, we can see the real importance of knowledge of durability. If the \$2/30cm last only five years, then the net present expense is \$640k. If the more expensive material (\$7/30cm) lasts 20 years, then the net present expense is only \$105k. Under these assumed conditions, the \$31k “saved” by choosing the initially less expensive material ends up costing \$535k more.

This analysis clearly shows the value of durability in making economically viable choices. Just an additional year of durability will yield ~20% decrease (3-10 years) and ~10% (10-20 years) in net present expense.

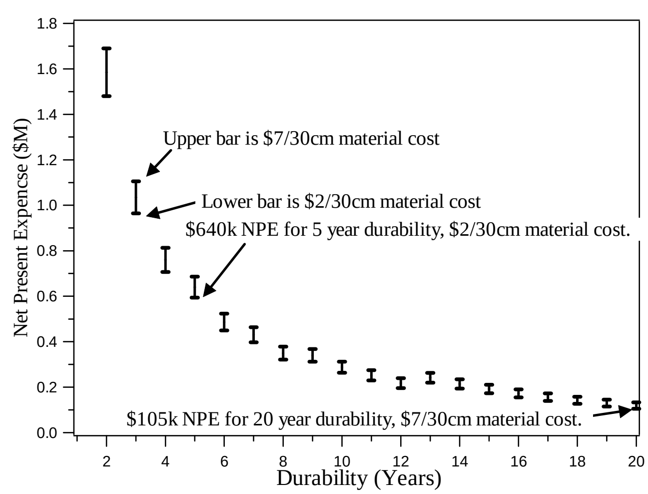

Figure 1, Net Present Expense plotted against years of durability for two different material costs for building joint sealants.