Hidden dangers

Rogers Corporation warns that there can be hidden costs that need to be included in product lifecycle cost analysis

ABOVE LEFT: The impact of a 100,000-cycle test on silicone (left) and polyurethane (right) foam

Rogers' Bisco silicone used for rail car seat cushions

Product lifecycle cost analysis, cost of ownership, life cost analysis (LCA), whole life cost, and cradle-to-grave costing – what do these terms have in common? The answer is they are all ways of evaluating the cost of a product throughout its time in service. They are certainly nothing new to the rail industry. In fact, many governments and municipalities require an LCA as part of a tender offering, and some transit authorities have expanded the criteria to include end-of-life costing and the triple bottom line (TBL or 3BL) of the cost impact upon environmental sustainability (the TBL takes ecological and social performance into account in addition to financial performance).

"Surprisingly, LCA is often misunderstood or only partially considered in railway tender awards," says Ken Kozicki, applications engineering manager for Bisco silicones at Rogers Corporation. "Some vendors enhance or misrepresent their respective products' life performance claims and either omit substantiated time-simulated data or exaggerate future savings. Typical cost models have the tendency to be over simplified and lack the flexibility needed to accommodate specific and customised variables not shared among transit authorities. Lastly, there are hidden, intangible and questionable costs that may be difficult or impossible to estimate."

Seat lifecycle analysis

While LCA can be assessed for any rail car component, this example uses a seating tender to scrutinise the validity of the model. "Within the interior, seating is one of the five most costly elements of the rail car and is at the top of the list for refurbishments," says Kozicki. To assess new-build costs with forecast refurbishment estimates, a whole cost analysis can be used.

A whole cost analysis would take into account the cost of the seating for the initial new-build delivery; an estimate of how long the seats will be in service before a full or partial refurbishment; the estimated cost of the refurbishment; and historical costs for replacements between refurbishments. Other considerations may include the cost of labour and lost revenue while the seat or rail car is in refurbishment or out of service. Ridership dissatisfaction because of seating discomfort or style could also be identified as an intangible cost.

"Regardless of the depth of such an analysis, this list is relatively common and generally used in the decision matrix," says Kozicki. "There are, however, hidden costs that rarely come to the surface."

Kozicki says that in the development of a seating lifecycle cost analysis, time to refurbishment is most commonly coupled to loss of comfort. "An argument can be made, however, suggesting compromised safety as another criterion, as it could become a big source of hidden cost," he adds.

The notion of compromised safety is predicated upon the global rail standards that address flame, smoke and toxicity (FST), such as ASTM D 3675, BS 6853, NFF 16-101 and DIN 5510. Full seat assemblies or the individual materials used in the construction of a seat and seat cushion are mandated to conform to specific FST measurements dependent upon the category

"Compromised safety could become a big source of hidden cost"

ABOVE: After a 100,000-cycle test, the silicon foam (on the left) remains largely unchanged

“What would be the FST result if a mass production seat were pulled out of service?”

of the train. “In practice, certified third-party FST test reports must accompany a seating tender as verification of conformance. Thus, the qualification testing of a material or full seat is of the utmost importance,” says Kozicki.

The language in the standards, as well as the testing methods, is the result of professional expertise and years of collaboration. “They are well defined, sophisticated and strictly reviewed,” says Kozicki. “Thus, the preparation of a vendor sample designated for testing submission will be of the highest level of engineering and craftsmanship. For example, a seat that is to be submitted for a British Spec (BS) 6853 Category 1a burn test will be meticulously assembled, with special attention to the wrapping of the fire barriers and upholstery fabric over the foam seat cushion. Objectively, the entire process is logical, legitimate and of the utmost regard for the safety of the ridership.”

Why, then, is this a discussion on hidden lifecycle costs? Kozicki’s answer to this question is built upon cycle-testing data, field observations and a hypothesis.

“It has been established that achieving good FST results is partially dependent upon the best-of-the-best material samples and assembly practices,” he says. “What would be the FST result if a mass production seat were pulled out of service after thousands of cycles and months or years of usage?”

Depending on the type of foam specified for the cushioning, Kozicki says the cycling of a seat can result in a loss in foam thickness, reduced spring-back force and compromised weight distribution. “This deterioration will cause the fit between the upholstered fabric, fire barriers and foam to become loose and crumpled,” he adds.

In a recent lab study performed in the UK, a 100,000 cycle test was conducted on two upholstered foam cushions – fire-retardant open-cell polyurethane foam and open-cell silicone foam. “The fire-retardant polyurethane material diminished in thickness by >10% with a spring-back force loss of >50%, while the silicone foam deterioration was negligible in both thickness and spring force,” says Kozicki. “In addition, the polyurethane cushion took on a compression set with a concave shape replicating the shape of the Jounce and Squirm impact apparatus. It was also discoloured, the remnants of the fire-retardant filler after having eroded away the cell walls of the polyurethane foam.”

In contrast, Kozicki says the silicone foam showed no shaped compression set and had no visual defects.

Back to LCA

“Would the 100,000-cycle tested polyurethane seat still pass the FST requirements as did its hand-crafted predecessor without any cycling or wear? Is this a compromise of safety? Also, is this a hidden cost that should be included in an LCA?” asks Kozicki. “A thorough lifecycle cost analysis should include a systems approach – analysing potential costs, with probabilities, of a system or module failure because of performance degradation of the component under evaluation. In the case of the seats, there may be a point in time when loss of thickness, spring-back force or a shaping from compression set could cause a system failure. The system failure could range from acceptable comfort to something as severe as non-compliance to an FST standard.”

Rogers Corporation, which makes Bisco MF1 open-cell silicone foam specially formulated for rail car seat cushions, will launch a Seat Cushion Cost of Ownership Tool at the upcoming Railway Interiors Expo in Cologne, Germany (15-17 November 2011). The tool enables users to simulate a specific scenario – size of seat cushion, number of seats per car, number of cars in the fleet, average number of years between refurbishments, cost of competitive materials, labour rates, estimated number of replacements, need for fire barriers and revenue loss. The calculator presents a picture of the total cost of ownership for each material along with metric tonnes of material that will be designated for landfill over the time period.

“It will be up to the user to add in the hidden costs – if there are any,” says Kozicki. “Hidden costs can be difficult to measure, but that doesn’t make them any less significant, especially when it comes to any potential compromise of safety.”