

The document objective is to provide a quantitative analysis on Total Cost of Ownership between Aluminum and Steel. The document was prepared by **Deloitte inc.** with the help of the **MAADI Group Inc.** and the **Aluminum Association of Canada (AAC)**. All the information contained within the document was provided by MAADI Group or a third party. All financial modeling was performed by Deloitte based on the data provided.

Life Cycle Analysis Aluminum vs. Steel



Project Lifespan: Examining the Real Total Cost of Ownership

The investment decision process requires updating when new processes, materials or benefits become available in the marketplace. Evaluation criteria often don't take into account a timeframe that represents the project's actual lifespan. This hinders the use of alternative processes and/or material choices that could realize long-term cost savings over a project's lifespan. These factors are clearly evident when it comes to selecting the right bridge material. Steel has previously been the preferred choice, without considering how alternative materials and processes will impact a bridge's total cost and lifespan.

Decision-makers should consider the **Total Cost of Ownership (TCO)** framework to compare the material selection of aluminum vs. steel over the project's lifespan. For major civil engineering projects, the methodology and project selected will demonstrate the importance of having an integrated long-term view of costing. This integrated approach demonstrates that over the project's lifespan, aluminum is a valid, cost-effective alternative to steel.

Evaluating True Project Cost

The TCO approach, adopted by the computer hardware, software and transportation industries, provides sustainable evaluation through its consideration of total costs over a project's life cycle when evaluating multiple solutions that often differ greatly in both benefits and cost structure.

For example, when purchasing a new bus, the acquisition cost might be attractive; however the product might suffer from poor reliability and expensive repairs. Only by considering cost over the entire lifespan of the bus is it possible to evaluate all alternatives. This methodology can be applied to large civil engineering projects.

TCO for Civil Engineering Projects

When evaluating a civil engineering project, four cost categories must be considered: acquisition, installation, maintenance & operations, and disposition. Compared to other industries, many civil engineering projects have a relatively high cost of acquisition, but maintenance and operation of a structure must be considered when investing in any civil engineering project. The TCO methodology evaluates alternatives, taking into account all costs in a project over its lifetime.

The Benefits of Aluminum

For many civil engineering projects, steel and concrete are often the chosen materials; however in some projects, materials such as aluminum offer benefits that must be considered. When replacing steel, aluminum provides the same benefits at a lower TCO, including:

1. **light weight** – aluminum is about one-third the weight of steel;
2. **strength** – aluminum profiles are as structurally strong as needed;
3. **non-corrosive** – aluminum is naturally highly corrosion resistant;
4. **conductivity** – aluminum conducts heat/cold better than other common metals and is twice as electrically conductive as copper;
5. **resilient** – aluminum combines strength and flexibility under loads;
6. **recyclable** – aluminum retains high scrap value and is reused/recycled indefinitely without losing any physical characteristics;
7. **accepts finishes** – aluminum may be permanently finished with liquid paint, powder coatings, anodizing, or electroplating;
8. **seamless** – complex shapes can be produced in one-piece extrusions without mechanical joining methods.

Cost, Lifespan Considerations for Engineers: Aluminum is the Durable, Maintenance-Free Material Choice for Structural Building Projects

Aluminum versus Steel: Characteristic and Cost Comparison

For many civil engineering projects, aluminum and steel are valid material options. This study compares aluminum to three types of steel protective finishes. In order to accurately compare a typical project, a pedestrian bridge project was selected. The analysis was conducted in urban and maritime environments. The urban environment represents the most common environment for such a project, while the maritime environment clearly demonstrates aluminum's corrosion resistance benefits.

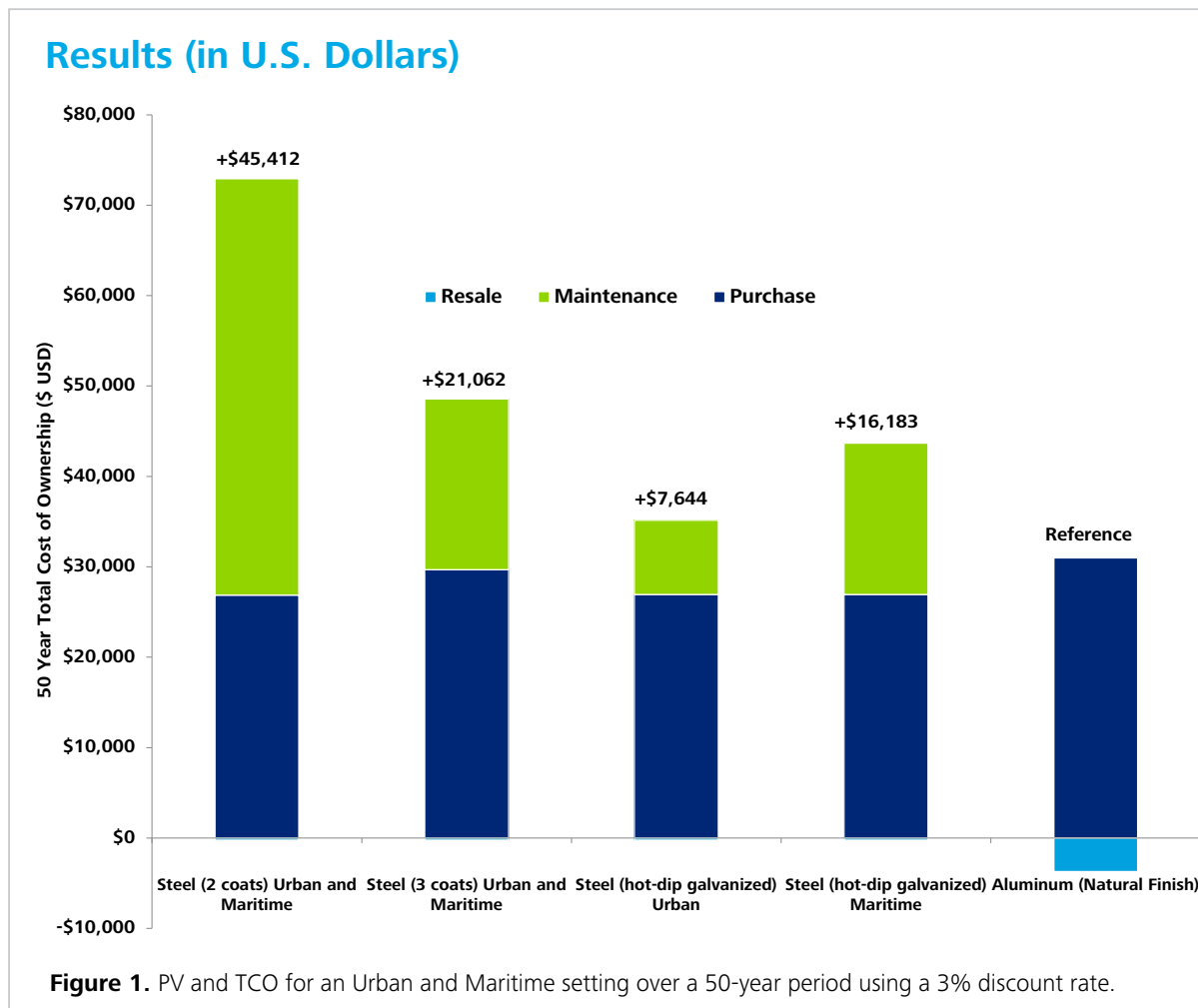
Installation costs are not specifically considered here, due to varying localization, weather, supplier's proximity, and designs. However, aluminum's light weight provides important savings over steel in transportation and manipulation during installation. Aluminum's weight advantage over steel becomes even more important as the size and weight of the bridge increases. A recent project highlights this dynamic where two identically sized bridges are considered. The steel structure in this case weighs 60 percent more than the aluminum; the increased weight required a larger crane and increased manipulation costs of more than 200 percent.

Figure 1 shows the **Present Value (PV)** for each cost and **Total Cost of Ownership (TCO)** for each option for a three percent discount rate. Using a three percent discount rate, aluminum has a better TCO than all other steel options by more than \$7,000 for

an urban environment, and by more than \$16,000 for a maritime environment. Aluminum has a TCO equivalent to galvanized steel after 33 years in the urban environment, and after 21 years in the maritime environment. When employing a six percent discount rate (see chart 3 of the complete study), aluminum has a better TCO than all other steel options by more than \$4,000 in all maritime and urban environments except Hot-Dip Galvanized in an urban setting; in this case, both aluminum and steel are close to being equal in terms of TOC at the end of 50 years. Aluminum has a TCO equivalent to galvanized steel after 50 years in the urban environment, and after 21 years in the maritime environment.

Any discount rate below six percent makes aluminum a better option than steel in all environments. Given the public financing of civil engineering structures like bridges, a lower discount is more likely. Using a six percent discount rate is conservative, since investments of this nature are often required and government agencies do not generate revenue or profit.

A recent article confirmed our results and highlighted the cost and technical advantages of an aluminum deck structure in Arvida, Quebec. The aluminum deck structure enabled the bridge to increase its load-bearing capacity, while reducing long-term cost of ownership. Additionally, the change in Canadian Standards Association bridge calculations for aluminum automotive bridge structures enables architects and engineers to develop designs using aluminum that respect the Association's rigorous norms.



Conclusion

Decision makers should not assume that steel is always the best option economically when investing in civil engineering structures. This analysis, using a pedestrian bridge example, demonstrates that aluminum can compete favourably with steel when the **Total Cost of Ownership** is considered. The case for aluminum becomes even stronger when the project is located in a highly-corrosive environment. Accordingly, while every project is unique, aluminum should have its place in the bidding process and be considered as an economical solution for civil engineering projects, since over its entire lifespan, an aluminum structure may prove to be the best option in terms of installation, maintenance, operation, and disposition costs. See our full article with methodologies and cost analyses by [clicking here](#).



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