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Gaithersburg, Maryland 20899-

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Shane L. Dettman, AICP
Senior Urban Planner, Urban Design and Plan Review
National Capital Planning Commission
401 9th Street, NW - Suite 500
Washington, DC 20004

Dear Shane:

This letter serves to convey the results of my analysis of the documents you provided entitled "Eisenhower Memorial: Tapestry Engineering and Technical Data Summary" and "Eisenhower Memorial: Submission for Preliminary Design Approval" from a metallurgical point of view. I will comment on the adequacy, completeness and results of the corrosion and other testing performed for the submission. It is my understanding that any testing of welds or welded materials for lifetime performance is not within the scope of this submission but is considered important for future analysis.

The submission proposes to use welded strands and yarns of 316L stainless steel to produce the semi-translucent tapestries for the periphery of the memorial. The material chosen (316L) is a highly corrosion resistant alloy of iron, chromium and nickel, and is particularly designed with lower carbon concentrations and added molybdenum to counteract potential problems with weld sensitization due to local chemistry changes during extreme heating and cooling. In my opinion, among the stainless steel alloys available it appears to be a good choice for this application.

The submission details a series of standard tests to examine the performance of both the base wire material and the welded tapestry. Those specified for mechanical performance (AAMA 501.5 (modified), ASTM E-1886, ASTM E-1996) appear relevant to this application, but not being a structures engineer I am not in a position to comment on whether this list is comprehensive and sufficient.

With regard to the metallurgical tests, ASTM E-8 is the basis for the yield and ultimate test of metallic materials and ASTM B-117 is the most commonly used extremely aggressive corrosion test for metals. The submission includes results from the B-117 tests on 11 wire types, with 5 different materials (316L, Ti, Bronze, Aluminum and Copper), several surface conditions (coated, "blackened", shiny), two morphologies (wires and yarns), and several gages and post-draw heat treatments (spring tempered, annealed).

In general, the results presented are entirely empirical, which is to say that the experimentalist reported their opinion as to the change in the appearance of the surface. In many tests, color changes and changes in apparent reflectivity are reported. It is more typical for a corrosion test to report changes in physical dimensions (lessening in wire diameter, for example) and actual weight loss due to any corrosion. Thus, it would be more quantitative for the wire samples to have been measured in several locations and weighed carefully before, at any pause in the test, and at the end to determine if there were any material loss. Although it is not expected that the stainless steel wires would exhibit measurable corrosion due to a 1000 hour salt spray test, it is left to your consideration whether these tests should be repeated and this additional data gathered. As for the ASTM E-8 strength testing, there was no data present in the submission for evaluation.

The choice of the corrosive environment does not appear to match very well with the environment that will be experienced on a daily basis by the tapestries. Although the immediate environment contains aerosolized salt from the bay and especially from de-icing road treatments in the winter, it is in concentrations that are far less than those used in B-117. Additionally, other atmospheric species such as sulfur dioxide and soot may cause corrosion problems, particularly if they become entrained in any metallic yarn to be used. Soot in particular may be a problem, as no common element causes a higher electrical potential driving galvanic corrosion than carbon. Testing in an atmosphere that is closer to, but still more severe than the atmosphere typical of Washington DC may be advisable.

In addition to a different atmosphere, another modification to the test might give results that are more useful in determining long-term stability of the base metal. Stainless steels were developed for general corrosion resistance, and do quite well in most environments. However, in the presence of salt and water, small defects in the protective oxide layer can lead to a type of corrosion called pitting, where the corrosion is very localized and literally drills holes in the stainless steel. Pitting is enhanced by the metal being under stress, so a more realistic test might be to also not simply hang the wire in the environment, but suspend a weight that brings the stress in the wire up to a level that it will experience in the highest-stress portion of the tapestry. This could reveal whether pitting might be an issue going forward.

I hope you find these comments of use to you as you evaluate the design, and I stand available to give further technical input. In particular, I would be interested in the scheme of tests to be used to evaluate the welding processes and resulting metal structures once you reach that phase in your process. These tests will be critical for assessing the lifespans of the tapestries.

Best regards,

Tim Foecke, PhD
Deputy Chief, Metallurgy Division
Leader, Materials Performance Group