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ECONOMIC CONSIDERATIONS IN THE USE OF CORROSION-RESISTANT A 242 STRUCTURAL STEEL FOR BRIDGE STRUCTURES

L. T. Oehler

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ABSTRACT: Corrosion resistant ASTM A 242 steel is compared with A 441 steel. Tangible benefits from use of A 242 are discussed, including specific savings through elimination of initial and maintenance painting. Intangible but real advantages of A 242 resulting from the elimination of bridge painting include elimination of traffic bottlenecks, hazards to maintenance employees, and possible spattering of passing vehicles which might occur during painting operations.

KEY WORDS: structural steels, corrosion resistant steels, maintenance costs.

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This report has been prepared to present further reasons why it is to the Department's benefit to continue evaluation of corrosion-resistant steel on several other bridges in addition to existing installations. A justification for additional use of A 242 steel has already been prepared and submitted to the Bureau of Public Roads, but additional background information is presented here.

Economic aspects of the use of corrosion-resistant steel, which ordinarily is left unpainted, have been analyzed previously in comparison with both ASTM A 36 structural steel (36,000-psi minimum yield point and 58,000- to 80,000-psi tensile strength), and ASTM A 441 high strength, low alloy, structural manganese vanadium steel (46,000- or 50,000-psi minimum yield point and 67,000- or 70,000-psi minimum tensile strength, with variations due to thickness for plates of 1-1/2 in. or less). Corrosion resistant ASTM A 242 high strength, low alloy structural steel has the same minimum yield point and minimum tensile strength as A 441 steel for the same thicknesses.

From an economic standpoint, it is necessary to select a given bridge (or bridges) in comparing A 242 and A 36 steels, since considerable savings in weight are involved due to higher design stresses permissible for the A 242 steel. However, in comparing A 242 and A 441 steels, the same design stresses are permitted, and thus the difference in weight of the structural steel required for a design of a specific bridge is not a factor in the analysis. R. B. Madison* has shown A 242 steel to have an economic advantage as a substitute for A 36, and costs for A 242 and A 441 to be nearly comparable, but with a slight advantage for A 441.

The purpose of this analysis and discussion is to compare the tangible (economic) benefits, and the intangible ones which cannot be assigned dollar and cents value but are nevertheless real, to the use of A 242 steel with those

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*Madison, R. B. Unpainted Low-Alloy Steel for Permanent Structures. Unpublished paper presented before the Construction and Structural Divisions Joint Session at the ASCE Environmental Engineering Conference, Kansas City, Mo., Oct. 20, 1965.

of A 441 steel in the light of current Michigan costs for initial and maintenance painting of bridge structures. In accordance with current practice, the A 242 steel would be left unpainted, but fascia beams or girders and the bottom surfaces of beams and girders would be sandblasted in order to obtain a uniform appearance. For the A 441 steel, the standard four-coat Michigan Department of State Highways paint system would be used.

The cost analysis comparison below is based on painting requirements for structures over expressways in urban areas. The existing structure and all structures where A 242 steel is now proposed are expressway situations in the Detroit metropolitan area.

The material cost of A 242 is higher than A 441 steel but the difference in cost varies according to thicknesses of materials as follows:

Web Plates up to 3/8 in.	$25.00 per ton
Web Plates 3/8 to 3/4 in.	$31.00 per ton
Flange Plates 3/8 to 3/4 in.	$25.00 per ton
Flange Plates 3/4 to 1-1/2 in.	$17.00 per ton

In order to determine the difference in material cost for a given situation, it is necessary to determine the ratio of usage for each thickness of material. This has been done for two three-span plate girder bridges which may be considered typical. For one bridge the increase in cost in using A 242 steel for the entire structure would be $22.40 per ton and for the other, $23.00 per ton.

Tabulation of Initial Cost Differences

	A 242, per ton	A 441, per ton	
Material Cost	$22.70	-------	
Blast Cleaning (fascia & bottom surface of stringers)	3.15	-------	
Shop Painting	-------	$15.00	
Field Painting	-------	15.00	
	$25.85	$30.00	
			$30.00 (A 441)
			-25.85 (A 242)
Savings in Initial Cost			$ 4.15

In this analysis the cost of sandblasting the A 242 steel to obtain a more uniform appearance is considered as $10.00 per ton. Again, the same two bridges were used to determine the cost of sandblasting only fascia surfaces and the bottoms of the stringers, thus reducing the cost in proportion to area reduction. For the two bridges, an average of only 31.5 percent of the steel area requires sandblasting. Thus, the cost would be $3.15 per ton. The costs of both shop and field painting as specified by the Department are considered to be $15.00 per ton for each operation. Thus, the initial cost saving in favor of A 242 is $4.85 per ton.

However, in addition to initial cost, the entire cost over the life of the structure must properly be considered in a design decision on selection of material. For a 30-year period, the following maintenance costs are estimated on the basis of current contract prices for repainting in Detroit:

Tabulation of Maintenance Cost Differences

	A 242	A 441
Maintenance Painting	-----	$95.00 per ton
Average Age for Repainting	-----	11.5 years
Cost for 30-year Maintenance Painting	-----	$284.00 per ton

Thus, when maintenance painting is considered in the analysis in addition to initial cost, the total saving through use of A 242 is estimated at $252.15 per ton. Although current prices have been used, any reasonable projection of future maintenance costs should be based on extrapolating future costs in line with past data. In the past five years the cost of repainting bridges in the Detroit metropolitan area has nearly doubled, from $50.00 to $95.00 per ton. Such a cost trend, if continued, would increase maintenance painting costs by the end of the 30-year period to $365.00 per ton for one repainting. It is true that other economic forces would probably come into play to reduce this cost increase, or many bridges would go unpainted.

At present, the age for repainting bridges varies from about 8.5 to 13 years, with an average of 11.5 years. The state has an inventory of nearly 3000 bridges. At a painting interval of 11.5 years this calls for repainting approximately 250 bridges a year. Thus, the economic potential of experimental evaluation of materials that do not require painting is a primary consideration for future planning.

In addition to the purely economic aspects of the problem of painting expressway bridges, other intangible benefits result from eliminating maintenance painting. These include three items, each of which has caused great concern:

1. Eliminating traffic bottlenecks.
2. Eliminating dangerous work and travel conditions.
3. Eliminating possibility of paint spatter damage to vehicles.

To alleviate current maintenance painting problems, certain severe limitations have been required; for example, to reduce traffic bottlenecks painting has been restricted to 10:00 a.m. to 2:00 p.m. daytime periods. Traffic control and precautionary measures for warning motorists of lane obstructions have been extensive, but even so, unfavorable motorist reaction results.

In summary, from all aspects further performance evaluation of A 242 steel for expressway bridges in the Detroit area appears fully warranted. Use of this material in field performance studies is the only way to determine whether the potential exists for enormous savings in the future by reduction of initial and maintenance costs.