Torres Rojas, Genara FOI#12478

From: afbraham@uark.edu
Sent: Wednesday, February 01, 2012 2:21 PM
To: Duffy, Daniel
Cc: Torres Rojas, Genara; Van Duyne, Sheree
Subject: Freedom of Information Online Request Form

Information:

First Name: Andrew
Last Name: Braham
Company: University of Arkansas
Mailing Address 1: 4190 Bell Engineering Center
Mailing Address 2:
City: Fayetteville
State: AR
Zip Code: 72701
Email Address: afbraham@uark.edu
Phone: 479-575-6028
Required copies of the records: Yes

List of specific record(s):
I am an assistant professor at the University of Arkansas, who will be teaching a unit of Life Cycle Cost Analysis LCCA of structures this spring. I read with great interest the article in the nytimes December 8, 2011 about the George Washington Bridge, and the repairs that the port authority will be doing in the upcoming years. Did you do a LCCA of the bridge, exploring different rehabilitation options? If so, did you write a report? And if so, would you be willing to send it to me? I am trying to find real-world examples of LCCA at work, and I think that this would be an excellent opportunity.

THE PORT AUTHORITY OF NY & NJ

FOI Administrator

February 1, 2013

Mr. Andrew Braham
University of Arkansas
4190 Bell Engineering Center
Fayetteville, AR 72701

Re: Freedom of Information Reference No. 12978

Dear Mr. Braham:

This is a response to your February 1, 2012 request, which has been processed under the Port Authority's Freedom of Information Code (the "Code") for a copy of a report on the Life Cycle Cost Analysis of the George Washington Bridge.

Material responsive to your request and available under the Code can be found on the Port Authority's website at http://www.panynj.gov/corporate-information/foi/12978-O.pdf. Paper copies of the available records are available upon request.

Certain material responsive to your request is exempt from disclosure pursuant to exemptions (2a) and (4) of the Code.

Please refer to the above FOI reference number in any future correspondence relating to your request.

Very truly yours,

Daniel D. Duffy
FOI Administrator

225 Park Avenue South
New York, , NY 10003
T: 212 435 3642 F: 212 435 7555

Life Cycle Cost Comparison of Options

In order to assist the Authority with the financial decisions that have to be made in investing funds toward the major rehabilitation of the "World's Busiest Bridge", the Parsons/HNTB team performed a life cycle cost analysis. The analysis covered a 50 year time period and compared three investment alternatives which were:

1. Construct the recommended rehabilitation scheme, fund the predicted periodic maintenance for a period of 20 years, and then construct a complete deck replacement which after 30 additional years will have 20 years of remaining life (salvage value).
2. Construct a complete deck replacement, fund the predicted periodic maintenance for 50 years after which time the useful life of the replacement deck will be consumed.
3. Construct only the priority and routine repairs, fund a high level of predicted maintenance for 10 years, and then construct a complete deck replacement which after 40 additional years will have 10 years of remaining life (salvage value).
4. Construct only the priority repairs, fund a high level of predicted maintenance for 10 years, and then construct a complete deck replacement which after 40 additional years will have 10 years of remaining life (salvage value).

In addition to the analysis of life cycle costs, user costs to the public for each life cycle alternative were also computed based upon the cost of delay due to construction impacts. The life cycle cost analysis results and user costs are shown in Table 1a.

The 50-year life cycle cost present worth for Rehabilitation is $230 million. For comparison, the 50-year life cycle cost present worth for the Full Deck Replacement is $315 million and for the Priority & Routine Repairs Only is $300 million.

While a complete deck replacement in "year 0" of the life cycle would provide the most desirable solution in terms of inconvenience to the public as reflected in the lowest 50-year sum of user costs ($110 million), lack of capital funding and the time required to complete a final design make this alternative impractical. Taking into account time for funding, the study of replacement alternatives, preliminary and final design, a deck replacement on the structure is a minimum of 5 years and up to 10 years in the future. As such, an interim solution is required.

Table 1a: Comparison of Construction Duration, Construction Cost and User Costs

Scheme	Duration Months	Construction Cost (2008 $)	Project Cost (2008 $)	PW – 50 Yr LCCA (2008 $)	50 Yr Sum of User Costs
Rehabilitation (20 Year Life)	20	$ 100 M	$170 M	$230M	$160 M
Replacement (50-70 Year life)	48	$ 300 M	$510 M	$315 M	$110 M
Priority and Routine Repairs (Not Recommended)	24	$ 55 M	$85 M	$300 M	$200 M
Priority Repairs Only (Not Recommended)	24	$ 45 M	$75 M	$285 M	$190 M

Even though Rehabilitation has only a 20 year useful life with additional periodic steel repairs required over that period of time, over the long term (based upon a present worth of $230 million) this solution is the more cost effective investment and the recommended alternate for implementation. It is noted that costs for the Priority & Routine Repairs are for comparison only, as these repairs alone, with deck replacement in 10 years, are not a feasible repair alternative due to uncertainty in the repair reliability and constructability at the joints. Priority and Routine repairs also have the highest user costs (most inconvenience to the public) over the 50 year period and have a higher present worth cost than Rehabilitation.

Evaluation Matrix of Options

In order to compare the three options proposed (deck Rehabilitation, complete deck Replacement, and deck Repair with Priority & Routine Repairs Only) and select one for recommendation, a weighted evaluation matrix was prepared using applicable parameters and relative assigned weights as shown in Table 1b. Each alternative was rated on a scale of 1 (worst) to 5 (best) for each of the categories, and the weighted total rating was computed using the relative weights. The alternative with the highest weighted total represents the best deck construction alternative overall.

Table 1b: Rehabilitation Option Evaluation Matrix

Factor	Relative Weight	Rehabilitation		Replacement		Priority Repair Scheme	
		Rating	Total	Rating	Total	Rating	Total
Present Worth (Life Cycle Analysis)	3	4	12	2	6	3	9
Relieves Stress in Deck and Other Members	5	3	15	5	25	0	0
Decreases Corrosion in Members	5	4	20	5	25	0	0
Avoids Emergency Closures	5	4	20	5	25	0	0
Construction Cost	3	3	9	1	3	5	15
Durability	4	3	12	5	20	1	4
Quality	4	2	8	5	20	1	4
Constructability	4	2	8	3	12	2	8
Ease of Maintenance	2	3	6	5	10	1	2
User Costs (Sum over 50 years)	5	3	15	5	25	2	10
Weighted Total:		125		181		52	

* Full Deck Replacement has the highest score but is not attainable to the limitation of funding at this time

While the evaluation matrix shows that complete deck Replacement is the preferred option when considering every possible impact on both the Port Authority and end user, as mentioned previously, from a financial perspective and due to practical considerations, the Rehabilitation option is a close second receiving the next highest rating, and is therefore, recommended as the best investment of Port Authority funding at this time..

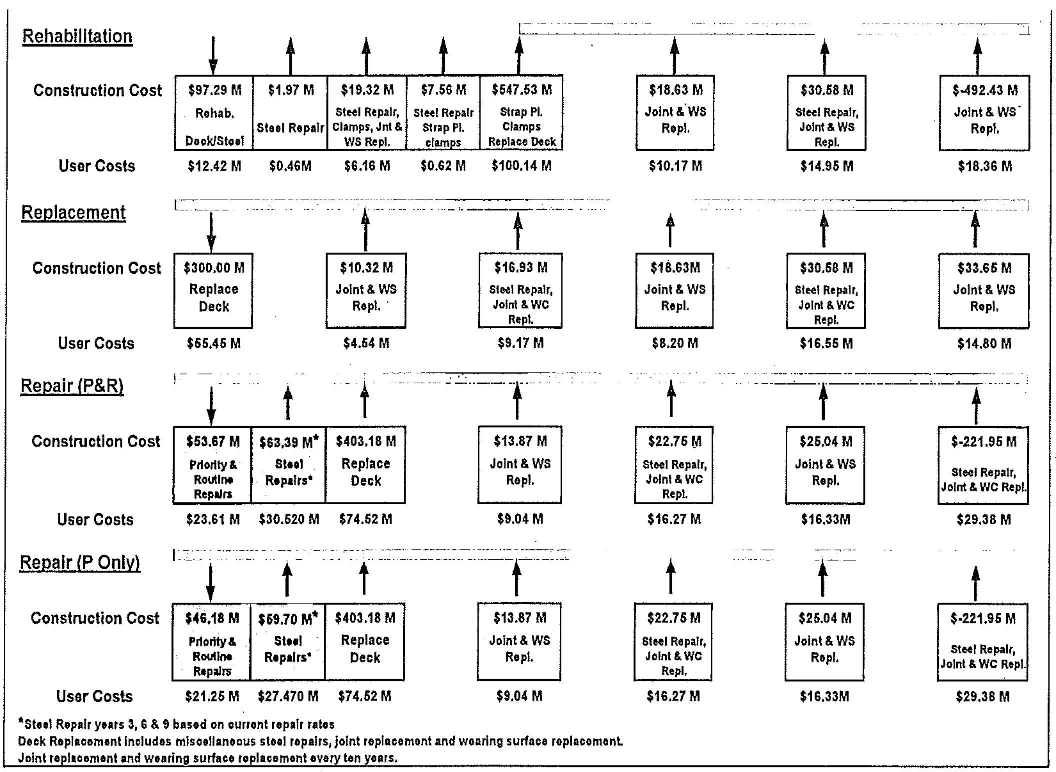
The recommended Rehabilitation alternative should be implemented, along with the other priority and routine repairs outlined in this report. Using dedicated nightly closures and the construction staging associated with Construction Staging Alternate 1, implementation is accomplished with moderate disruption to traffic, a high level of worker safety, and reasonable construction duration while offering a high level of value and quality for the investment.

10.1 Life Cycle Cost Analysis

Figure 10.1 illustrates the components of the life cycle cost analysis over a 50 year period, with each vertical grid line representing 5 years. In this figure it is clear how the initial construction cost and the maintenance costs over the 50-year life factor into the financial investment required for each scheme. Figure 10.1 also shows the user costs over time.

Table 10.2 below summarizes the Life Cycle Cost Analysis performed for three comparisons of repairs and the associated costs over three different repair lives. As Alternate 3 is the preferred rehabilitative repair, in terms of both initial cost and construction duration, it was compared to the two other scenarios to judge the predicted total costs of repair. These scenarios are a total deck replacement at "year 0" of the life cycle and the "do nothing" option of merely making patch and replace in kind priority and routine repairs. Performing priority and/or routine repairs can only be followed for a 10 year maximum period after which a total deck replacement is required.

Figure 10.1: Life Cycle Cost Components



The assumed future repairs and costs as depicted in Figure 10.1 included:

For Rehabilitation (Alternate 3): full deck replacement in 20 years; steel repair frequency of 5 years at 5% of current deterioration prior to deck replacement, followed by steel repair frequency of 20 years at 5% of current deterioration after full deck replacement. Typical Joint Cost = $37,500

For Full Deck Replacement: steel repair frequency of 20 years at 5% of the current repair deterioration. Typical Joint Cost = $25,000. In addition due to the high truck fatigue loading measured in the WIM analysis, it is assumed that 5 years after the rehabilitation, there will be a need to install pairs of clamps as described further below.

For Priority & Routine Repairs: full deck replacement in 10 years; steel repair frequency of 3 years at the current rate of 24% new priority repairs each biennial inspection prior to deck replacement, followed by steel repair frequency of 5 years at 5% of current deterioration after full deck replacement. Typical Joint Cost = $50,000

For all repair comparisons: joint replacement every 10 years; wearing surface replacement every 20 years. All joint costs include longitudinal and transverse joint repairs. Wearing surface replacement cost is approximately $4,000,000. Steel repair base cost is $35,000,000. Full Deck Replacement cost is $300,000,000. The analysis is based upon an inflation rate of 3% and an interest rate of 7.5% as approved by the Port Authority. Alternative interest rates are shown in the appendix to determine sensitivity. All costs noted here are present costs.

To the Rehabilitation scheme costs above, will be added the future cost of maintenance repairs at the orthotropic deck strap plate connections for the portion of deck that will be left in place after the rehabilitation construction is completed. The ultrasonic peening will extend the life of the strap plate filet welds, however, due to the presence of truck loading documented by WIM measurement that exceeds the fatigue loading design criteria proposed for the interim AASHTO LRFD code as further explained in Report Volume II, it is anticipated that commencing approximately 5 years after the rehabilitation is complete a limited number of additional strap plate welds will crack or strap plate bolts will break at secondary floor beam locations 2 through 11, since secondary floor beams number 12 and 1 are replaced under recommended repair alternate 3. The repair for this deficiency will be the installation of the clamp detail shown in Figure 10.2. It is estimated that approximately 75 strap plate locations will require the installation of a pair of clamps each year due to weld cracks or broken strap plate bolts at an estimated cost of $630,000. This cost will be added to the life cycle cost analysis.