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"Rehabilitation of a Railroad Swing Span Under $800,000"

by

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Rehabilitation of a Railroad Swing Span Under $800,000

INTRODUCTION

Owners are being increasingly tested to carefully balance their movable structure maintenance, repair and rehabilitation work with limited funds. The paradox is that the longer the repairs, rehabilitation and maintenance are delayed, the more expensive the repairs and maintenance costs become. The challenge for the owners and the designers is to develop a plan to identify when structures should economically be repaired or rehabilitated and a plan that permits the needed work to be performed which minimizes the dollars spent. Most clients become very hesitant when you indicate that the costs are 7 figures plus to repair or rehabilitate something that cannot be seen and will only get worse without repairs. What can be seen is costs, repair calls, operational delays and log reports which are telling information about a particular structure. As consultants we are sometimes not involved in all of these factors as a bridge project comes about. With ever increasing demands on our resources, everyone needs to be involved in these issues to handle a project that has definite needs and costs with only $800,000. Too many times the answer to how do you rehabilitate a structure for $800,000, is that you hire a consultant and you do little or no work on the bridge. How this project was handled is the topic presented in this paper.

On a unique project with the BNSF, HNTB teamed with the BNSF to tackle just such a project. The BNSF Bridge 37.0 over the Snohomish River in Everett, Washington is a 77-year old swing span. This project includes major repair, rehabilitation and replacement to selected items to minimize maintenance costs and to restore reliable service to a 260 foot long through truss center bearing swing span. The project cost nearly 4.5 million dollars and was completed over a 5 year time frame established jointly with the BNSF. When this project was first developed and the costs were revealed, the BNSF made it clear that they were NOT going to spend nearly 4.5 million dollars in one year out of one budget, there were too many other needs. A COMMON PROBLEM TO ALL OF US. The fact that the operations maintenance department was spending $250,000 to $300,000 a year in maintenance costs was a compelling reason to look at the project further.

Studying the way the BNSF funds and builds most structural type projects, most are relatively small and often well under 1 million dollars. The idea developed by the BNSF and HNTB was to devise a logical plan to spend about $750,000 to $850,000 per year which the BNSF could take to upper management and possibly fund that type of project. We were tasked with coming up with a solution to this problem.

The accounting for the project was by calendar year and includes all costs associated with the engineering, labor and materials. What we discovered was that the funds had to be spent by approximately November 10 to make the year end books, but you didn't know for sure until next February or March exactly what the bottom line was. If you went over on costs, then that overage came out of next years moneys and if you were under, those excess funds were lost. This forced a majority of the work activities, except for engineering, to occur between March and November. The project was engineered and designed in reality from a funding point of view for an 8 to 9 month period. These issues were handled in part by performing the engineering in a staged manor. Items with long lead times were designed first, the supports and attachments were then designed for that specific piece of equipment. The supporting elements were typically shop drawing designed for the BN personnel to fabricate on site and install. The dollars that the BN personnel spent were almost instant due to the accounting procedures. A budget was set up each year for the BN forces to work on this project. This was not the only project that the BN personnel were responsible to work on and emergencies delayed this project on more than one occasion. When there were changes in the work, adjustments in the design, ordering, billing or payments were made to stay with in the yearly budget. The project was very dynamic and changed focus constantly throughout the design process. It required that the entire design and construction process be reconfigured and tailored to the activities necessary at this location.

HISTORY

Bridge 37.0 was originally constructed in 1921 and is a unique structure due to several design features built in by the Great Northern Railroad, now the BNSF. This bridge was the tenth structure to the Northeast of Seattle and is one of six similar swing spans on this line. Bridge 37.0 is the only bridge of the immediate nearby four to have end lifts, the other bridges all have end wedges. Bridge 37.0 was also the only bridge to have the end lifts, center wedges and rail joints powered by pneumatics. The extensive maintenance requirements of the pneumatics and air storage system was the primary reason for the rehabilitation. BNSF estimates that the pneumatic maintenance over the last several years ranged from $250,000 to $300,000 per year. These maintenance costs and maintenance calls became a constant requirement and a routine that was budgeted into the Northwest operations maintenance department annual budget. The method of operation became so practiced that it was considered normal maintenance and no long term solutions were developed for nearly 20 years.

Bridge 37.0 has since had several center pivot bearing repairs and replacements. Repairs to the rack and rack pinion became more frequent, but were considered minor and no reason for concern. Therefore, funds for rehabilitation were allocated to other more serious problems. In the late 1980's a pneumatic hose operating the end lift mechanism ruptured as a train crossed the bridge. The end lifts collapsed causing the rail joints easer bars to pierce the passing train consequently derailed the train on the bridge. The derailment caused minor structural damage to the bridge, but closed the span to navigation for nearly one week. This derailment and subsequent operating failures over the next several months caused the Burlington Northern Railroad (BN), now the BNSF, to focus attention towards this old operating system. The BN looked at numerous solutions such as new pneumatics, hydraulics and machinery. HNTB was hired to investigate and evaluate several of these options and make recommendations to assist the BN in the planned repairs.

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The existing bridge wedge, end lift and easer bar operating machinery was powered by pneumatic cylinders. The cylinders were in very poor condition which required frequent and numerous repairs. These devices needed immediate replacement. Due to the moisture associated with the pneumatics, most of the supporting steel in the area of the cylinders and the valves was in poor condition and would also need replacement. The turning machinery, consisting of open gearing and bronze bearings, was in such poor condition that it was determined that only one of the two rack pinions would be engaged with the rack at any one time. The rack pinions would not engage the rack properly causing the pinions to ride out of the rack during span movements. The rack was out of round by nearly 3 inches in some locations. The center pivot bearing had been replaced 4 times prior to this repair and allowed the span to move lateral by as much as two inches. This bearing needed to be replaced or rehabilitated for any operating mechanism to function properly. The electrical system was the source of numerous failures including allowing the end wedges to collapsed under a train. Clearly these repairs were not going to be rehabilitated for $850,000 in one year, however what repairs could be accomplished for $850,000 would greatly reduce the staggering maintenance costs. One additional consideration was the type of repairs that could be made with a reasonable life expectancy. Replacing items with newer components that would require repairs in a few years was not acceptable.

The other factor involved was that this particular bridge had been examined by three other consultants and several equipment suppliers to help render a solution. The BNSF field staff was tired of studying solutions and HNTB was forced to revisit several previous solutions to satisfy the BNSF and make way for the current solution. All of the previous ideas were examined, discussed and researched as part of the investigation. Do to the time required to do this studying, we agreed that the first portion of the project would be a design build project. Through vigorous support from the maintenance side of the BNSF, the project made the first hurdle and monies were allocated for the first year. Many people within the BNSF thought that this was all the work that would be accomplished. The remainder of the project would not be completed. Any other repairs would require that the monies come from operations.

The largest single maintenance expense was the pneumatic operating system. HNTB focused on repair techniques that would address the repairs, decrease maintenance costs and improve reliability. The dilemma was that if the system had been replaced in kind, it would be newer than the existing and although the maintenance would be less, ease of maintenance would not be improved. Longer term, the costs of maintenance would again increase and similar repairs would be required. The client was looking for a new solution, not a repeated "mistake" of the past. The project expanded further into updating the access and maintenance to these areas. Restrictions of no significant closures to rail traffic for repairs and limit navigation outages were enforced. New work rules imposed by the FRA also changed the scope and added tasks necessary to successfully complete the project. The work windows were 5 to 6 hours each day to do all work, then rail traffic would resume. The operation for navigation was critical during high tide because there is only 6 to 8 feet of clearance available for the passage of vessels. Navigation closure was obtained from the USCG for one week to perform work.

Time constraints dictated the repair approaches and method of rehabilitation. Now the solutions were to place equipment in new locations. The new operating equipment requires the need for additional control equipment, thus the scope continued to evolve. As the plan was finalized for the first time it became clear that there was little accomplished by spending only $850,000. The reality was that $850,000 would almost surely be wasted because of the poor condition of the neighboring equipment. Therefore, the neighboring equipment would also require rehabilitation to make a complete long life, reliable operating system. It was obvious that more funds were needed.

What is unique is the project mixes traditonal design, plans and construction with the approach of a design build and incoprpated the staff of the client with the use of a consultant. The investment of maintenance costs were directed to a major capitol project in the attempt to reduce the overall operating costs to the BNSF. The project was broken up in phases based upon the areas creating the greatest demands on the maintenance staff and the areas that could be completed in a calender year. Since a project of this magnitude had not been attempted by the BNSF and the fact that continuing funding was not guarranteed, or assured for the following year, we were charged with satisfying the owners multiple agendas. The final sequence started with the replacement of the pneumatics which accounted for the single most significant portion of the maintenance costs.

The process followed on this project is almost backwards of a typical design job. The whole job is conceptually designed and prioritized. The cost estimates are developed and the project is then altered, tailored, and reconfigured to fit the project costs. The phases are developed further and a sequence of construction is prepared to look at the obstacles and determine the time constraints. The sequence presented to the U.S. Coast Guard to show the anticipated time of repairs and request a navigation closure. The plan now takes its final shape as we have tentative commitments and know the time constraints to perform the work. The final design process can now be completed.

The design of the project consisted of a mixture of design-build, traditional design, and plan preparation as required to meet the time constraints. The BNSF did a large portion of the work themselves. HNTB prepared plans, procurement specifications, ordered equipment, and prepared shop drawings as necessary for fabrication of equipment.

RESULTS

The project was completed approximately 8 months behind schedule due to a piece of equipment that was not received on time. Components were fabricated in the USA, Canada and in Yugoslavia. The overall phasing of the project was a success and the BNSF has undertaken two additional projects with a similar approach. The construction transitions from phase to phase went smoother than any one expected with only one delay, restoring the bridge to navigation by 12 hours and a two hour rail delay. This was due to the interfacing with the existing 480 volt control system that required some last minute re-wiring. Operation of the new end lift machinery cut the number of calls to the bridge from over 300 to 4 in the first year. The installation of the center wedge equipment went smoothly with only a minor delay during the initial alignment process. The new electrical control system now provides complete automated operation of the span utilizing a Allen Bradley Smart Motor Controller on a two-speed motor and an Allen Bradley PLC control system. All of the electrical system was replaced as part of the repairs. The end lift mechanical rollers and equipment was repaired and rehabilitated. One complete assembly of the end lift mechanism was fabricated and installed. The corner removed was then rehabilitated and the process continued. The new machinery was connected to the existing hand crank equipment to provide a seamless transfer from the old to the new. The easer bar equipment was replaced in the same location with new equipment of a different configuration. The center wedge machinery was again connected to the existing hand crank assembly and the drive shaft was replaced. The existing gearing was retained and utilized as part of the new drive system. New handrails, walkway platforms, and access platforms were furnished throughout the span. A new control house was furnished and the operator was relocated to the top of the truss as part of the rehabilitation. The turning machinery was replaced with a new system located in areas between the stringers away from the existing machinery to allow for pre-assembly of the equipment. The center bearing was not replaced, but a rim bearing assembly was installed to provide lateral support of the swing span during operation. The center pivot pier was renovated to accommodate the rim bearing assembly.

Maintenance costs are down significantly. The design utilizes several features to minimize maintenance costs. The reducers are filled full using a synthetic lubricant. Most bearings are spherical roller bearings with seals using a synthetic lubricant to reduce frequency and cost of maintenance. The couplings are using a lubricant that does not require adding to on a routine basis. Load monitoring is a part of the PLC control system and will alert the operator of unusual load conditions. The pneumatics are gone and the areas that were effected by the air tanks have been patched or repaired. The BNSF is operating this span with less than one maintenance call per month for anything. There comment was, "We wish that they were all this easy to maintain".