BRIDGE INSPECTION AND THE EQUIPMENT IT DEMANDS

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BRIDGE INSPECTION

During the bridge construction boom of the 1950's and early 1960's not much emphasis was placed on inspection and maintenance of bridges. The greatest number of bridges were built in the 1960's. This coincides with construction of the Interstate system. The increase in public and commercial traffic and the aging process means more bridge maintenance and rehabilitation work in the coming years. This also means that the structures will require close monitoring and in some cases the frequency of the safety inspections will need to be increased.

In December of 1967 the Silver Bridge, spanning over 2000 feet at Point Pleasant, West Virginia, suddenly collapsed into the Ohio River killing 46 people. The tragic collapse aroused national interest in the inspection and maintenance of bridges. Congress added to the Federal Aid Highway Act of 1968 a section which required the Secretary of Transportation to establish a national bridge inspection standard. The act also required the Secretary to develop a program to train bridge inspectors.

NATIONAL BRIDGE INSPECTION PROGRAM IMPLEMENTATION

During the 1970's many steps were taken to ensure proper inspection and maintenance of in-service bridges. The National Bridge Inspection Standards (NBIS) were created in 1971. These standards established national policy regarding the application of the standards, inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and inventory.

To implement the policies three manuals were developed: Federal Highway Administration's (FHWA's) Bridge Inspector's Training Manual / 70 (Manual 70), The American Association of State Highway Officials (AASHO) Manual for Maintenance inspection of Bridges, 1970, and the FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (the Coding Guide). These manuals were important to the early success of NBIS.

The Surface Transportation Assistance Act of 1978 established Federal funds for bridge replacement and required all public bridges over 20 feet in length to be inspected and inventoried in accordance with NBIS by December 31, 1980. In the 1980's more structural failures occurred which created a need for three new supplements to the Bridge Inspector's Training Manual / 70 (Manual 70): Culvert Inspection, July 1986, Inspection of Fracture Critical Bridges, September 1986, and Scour at Bridges Technical Advisory, September 1988. In 1991 the Federal Highway Administration published the Bridge Inspector's Training Manual / 90 (Manual 90). This manual replaced the Bridge Inspector's Training Manual / 70 (Manual 70).

INSPECTION PERSONNEL QUALIFICATIONS

The *Inspection Manager* is the person in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and inventory. This individual shall possess the following minimum qualifications: 1) be a registered professional engineer; or 2) be qualified for registration as a professional engineer under the laws of the State; or 3) have a minimum of 10 years experience in bridge inspection assignments in a responsible capacity and completed a comprehensive training course based on the Bridge Inspector's Training Manual, which has been developed by a joint Federal State task force.

The *Inspection Team Leader* is an individual in charge of a bridge inspection team. This person shall possess the following minimum qualifications: 1) have the qualifications specified as the person in charge of an organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and inventory; or 2) have a minimum of 5 years experience in bridge inspection assignments in a responsible capacity and completed a comprehensive training course based on the Bridge Inspector's Training Manual, which has been developed by a joint Federal State task force; or 3) current certification as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET).

AN INTERNATIONAL PERSPECTIVE

Other countries have experienced structural problems with their bridges. For example a major bridge collapse in South Korea aroused national interest in their bridge inspection and maintenance program. The South Korean

government is now developing a national bridge inspection program. South Korea is taking delivery of five Under Bridge Inspection Units as part of their commitment to a bridge inspection program. Austria, Russia and Vietnam also are reviewing their bridge inspection programs and are interested in purchasing Under Bridge Inspection Units.

BRIDGE TYPES

Through the years many different types of bridge designs have been developed and the need for many different types of equipment to access the structural components of a bridge has become necessary. The size and shape of the bridge will dictate the procedure used for inspection. A combination of primary structural components may be used in the construction of the bridge, thus requiring several inspection techniques for the same bridge. The bridge designs in existence today include: prestressed concrete multi-beam, girder floorbeam, slab span, concrete tee beam, adjacent box beam, steel box girder, reinforced concrete frame, deck truss, through truss, deck arch, through arch, suspension, cable-stayed, bascule, steel culvert, and concrete box culvert.

HANDS-ON INSPECTION

The concept of hands-on inspection has developed, as inspectors have realized that a thorough inspection of a bridge requires getting close enough to the bridge member or component so that it can be touched with the hands. During a hands-on inspection the inspector is more likely to see small structural deficiencies which require minor maintenance. If minor structural deficiencies are undetected they could become major repairs, or worse a failure of a major structural component. The owner of the bridge will be in a better position based on accurate inspection reports to schedule maintenance and repair of the bridges maintained in their bridge inventory.

INSPECTION ACCESS EQUIPMENT AND VEHICLES

By design different types of bridges require different inspection access equipment. For example, a one span prestress concrete multi-beam bridge with a horizontal span of 30 feet over a two lane gravel road with a vertical height of 16 feet, would probably require a ladder for the inspection of the structure. However, a bridge like the New River Gouge Bridge, near Beckley West Virginia, would require the use of sophisticated equipment such as an Under Bridge Inspection Unit (Inspection Access Vehicle) to perform a comprehensive inspection. Listed below are the types of equipment available.

Access Equipment

- *Ladders* can be used to inspect the underside of the bridge and the substructure units when height and access under the bridge is not a problem. Ladder usage should only include portions of the bridge that can be reached comfortably without excessive leaning.
- *Rigging* is sometimes used to access areas not reachable by ladders. Rigging is used in operations when the inspector will be at a location for a relatively long period of time. It is used more often for maintenance due to the fact that maintenance use often requires more time to complete a task.
- On structures that are less than 40 feet high and over ground with little or no traffic, *scaffolds* may be an access alternative. Scaffolds are used in operations in which the inspector will be at a location for a relatively long period of time.
- For structures over water, a *boat or barge* may be needed for access. Some inspection as well as photos taking can be done from a boat. A boat or barge also may be required for under water inspection.
- Bridges which are built over rivers and streams require special inspection techniques and equipment for the inspection of substructures. *Diving gear* is sometimes necessary to inspect the bridge piles and foundations. Only qualified diving personnel should perform this type of inspection.
- *Climbers* are mobile inspection platforms that "climb" steel cables. They are used for inspection of high piers or other long vertical faces of bridge members. Climbers are sometimes referred to as "spiders."
- A *float* is a wood plank work platform hung by ropes to provide access. Floats are used in operations in which the inspector will be at a location for a relatively long period of time.
- *Bosun chairs* are suspended from cables and carry one inspector. They can be raised or lowered with block and tackle devices.
- On some structures, if other methods of access are not practical, inspectors must *climb* the bridge elements. Safety awareness should be foremost in the inspector's mind when utilizing this technique.

Access Vehicles

- A *manlift* is a device with a platform or bucket capable of holding one or more inspectors. The bucket is

attached to a hydraulic boom that is mounted on a carriage. An inspector "drives" the carriage using controls in the bucket. This type of vehicle is usually not licensed for use on the highways. Some manlifts are very nimble and can operate on a variety of terrain.

- A *bucket truck* is similar to a manlift. However, it can be driven on the highway and the inspector controls the boom movement from the work platform bucket.

Under Bridge Units

Under Bridge Units are specialized machines designed to reach out and under a bridge structure while parked on the deck. These units allow access through the use of articulating booms to bridge members not normally reachable using other forms of equipment. Under Bridge Units have the following features and variations:

- Reach Capability: Varies from 30 to 60 feet
- Elevating First Boom: The first boom will reach vertically to allow the boom assemblies and platform to rotate over fences and other objects.
- Rotating Turrets: Provides horizontal movement
- Axle Locks: Allows the truck to move during inspection operations
- Telescoping Third Boom: On most machines the third boom has the capability of extending and contracting which allows for greater reach under a structure.
- Articulated fourth boom: Some units have a fourth boom that allows vertical movement under the structure. This capability is particularly useful on bridges with deep superstructure members.
- Capacity: Most units have a two or three person bucket on the end of the last boom. Weight capacity varies from 500 to 700 pounds.

Access Vehicles vs. Access Equipment

An Under Bridge Unit will be quicker than using a ladder or rigging to inspect a structure. Further more an Under Bridge Unit is mobile which means it can be moved quickly to various inspection sites. In addressing the time-saving effectiveness of a Under Bridge Unit the following questions should be answered:

- What type of vehicle is available?
- How much of the bridge can be inspected using the vehicle?
- How much of the bridge can be inspected from one setup?
- How much time does it take to inspect at each setup?
- Does the vehicle require an operator or driver other than the inspector?
- Will the use of the vehicle require special traffic control?
- Will access be possible without the use of the Under Bridge Unit?
- How much time can be saved by using an Under Bridge Unit vs. Other access equipment.
- How many bridges will the Under Bridge unit be used for?

SPECIAL EQUIPMENT TRAINING REQUIREMENTS

Some types of bridge inspection equipment require specialized training in both operation and maintenance. No person should be permitted to operate a machine without first being trained in its use. Training must be systematic and thorough, and should include these points:

- Read and be familiar with the contents of the operation and maintenance manual.
- Know the location and function of all the controls in the unit.
- Know and observe the posted capacity of the unit.
- Read the danger, warning, and caution labels that pertain to the various operation modes and conditions.
- Know how to conduct a thorough pre-operation inspection of the unit and what to look for at each checkpoint.
- Know the operation sequence of the unit.

SPECIALIZED EQUIPMENT TRAINING PROCEDURES

An individual who has been trained on one brand of equipment is not necessarily qualified to operate other machines. Machines from other manufactures vary as to capacity and operation characteristics. Training should be conducted with the entire crew that would normally operate the unit. By learning the operational aspects of the equipment together, the crew will function as a safer group. This becomes particularly important in the event of an emergency. A crew that has been trained as a group will be able to react faster and with more cooperation. Even though emergencies may never occur, the crew that has reviewed their procedures together will be best equipped to cope with all situations that may occur. The

importance of operator training can not be minimized. A good training program will result in less equipment down-time, and more importantly, will help prevent serious or disabling injuries to personnel.

SUMMARY

With bridge and highway maintenance budgets tight, managers are forced to find ways to control costs. The manager also knows that the number of bridges in their jurisdiction will not decrease and that the federal government requires that each bridge that spans over 20 feet must be inspected every two years. The manager must find ways to maximize the bridge inspection budget. It also must be kept in mind that a hands-on inspection will give the manager a more accurate assessment of the condition of the bridges in their jurisdiction. A hands-on inspection requires a greater commitment in personnel and equipment. Specialized bridge inspection equipment may be a way to maximize the inspection budget and assure that bridges are safe.