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"Technical Aspects of Control Houses on Movable Bridges"

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INTRODUCTION

The design of control houses, gate houses and machinery houses on movable bridges is governed by their functional requirements. This does not preclude, however, an aesthetically pleasing design which is integral with the design of the bridge.

The general public as well as engineers develop an emotional attachment to the design of these diminutive structures. Most bridges are static objects, at least to the casual observer who is not aware of the subtle movements of a fixed bridge. A movable bridge by contrast fascinates us, because on demand the entire mass of steel which can support the heaviest rail and truck loads is made to part to allow marine traffic to pass. It is the activities which take place in the control house which animate the bridge. The 'troll' operating the bridge is endowed with the power to permit the priority of one form of transportation over another. Since in our society this barrier to free flow of traffic is deemed undesirable, most movable bridges occur adjacent to developed areas where fixed high level bridges cannot be built without destroying the very communities they are designed to connect. Over time these bridges become landmarks in the communities where they exist. This is due to both their physical presence and the impact they have on the lives of local residents.

PROGRAMMATIC REQUIREMENTS

The control house must contain all required mechanical and electrical equipment to operate the bridge. Emergency generators and fuel are often located in the control or machinery

rooms. Access to this equipment for maintenance must be provided. The control house must provide comfortable quarters for the operator with maximum visibility of the roadway and marine traffic. It must provide for the life safety of its occupants. The enclosure, which is often subject to extreme environmental conditions, must be weatherproof. The house must meet all criteria for ease of maintenance and security against vandals. Finally the house should enhance the design of the bridge and complement the surrounding architectural environment.

DESIGN CRITERIA

The design of a new control house or the rehabilitation of an existing house must conform to established design criteria as follows.

AASHTO Standard Specifications for Movable Highway Bridges, Section 2.1.5 specifies basic requirements.

- It shall be fireproof and weatherproof.
- It shall be large enough for easy access to machinery.
- There shall be at least one window on each side of the house.
- Openings shall be large enough to admit passage of the largest machinery.
- It shall be located to afford a clear view of operations on the highway and on the waterway.

AASHTO Standard Specifications for Highway Bridges, AREA and State Bridge Design

Standards address the required structural criteria.

OSHA regulations establishing safety in the work place include requirements for stairs, ladders, and inspection platforms, as well as protection of lighting fixtures and storage of flammable materials.

The **National Electric Code** gives specific criteria regarding clearances around electrical equipment and egress from these spaces.

State and Local Building Codes cover life/safety issues specifically egress requirements. This presents the designer with a dilemma, since in many cases bridge operator houses do not conform to a listed building type. However, it is essential to have criteria to establish egress requirements. Unwarranted liability occurs on the part of the design professionals and owners if there are no criteria used in establishing requirements. Each code has its definitions for occupancy classifications. For example, under the **BOCA National Building Code**, we have interpreted the room where the operator is to fall under a business classification. The **New York State Building Code** has a miscellaneous use group listing towers among other miscellaneous structures. For design of these miscellaneous groups we are referred to the **NFPA Life Safety Code**. NFPA requirements are generally reasonable and appropriate to follow if no guidance is given under local and state codes. A control tower would generally require one enclosed exit stair. Egress should not pass through the electrical equipment room.

ADA requirements should be established by the owner and depend on the job description. If the job description includes maintenance or emergency duties, accessibility issues are thereby minimized.

Lastly, requirements of agencies and review boards which have jurisdiction over the architectural treatments or historic aspects of the bridge must be met. This covers requirements for approval of the design by aesthetic review committees or agencies imposing requirements for historic appropriateness.

In a new or replacement structure the aesthetic requirements are usually not defined, except perhaps that a significant bridge (and control house) is desired. Usually our advice is to try not to imagine what various representatives expect the control house to be. Rather, we envision what the bridge should look like and design the house accordingly. The interaction with the parties involved in final approvals varies greatly. It is important to meet with these groups early and define parameters for design. The design parameters elicited should define goals, not specific features. Is the bridge to serve as a gateway or a monument? Are there particular features of the local architecture which are significant and should be recalled?

In New York City there is a formal review by the **Art Commission**. The Commission's task is to review projects built with city funding to assure that visual aspects of the project have been considered and that the design is compatible with the surrounding environment. Other communities have reviews which are less formal.

If the bridge has been deemed to have historic significance, it is critical to establish the nature of that significance. Bridges which have been determined to be historically significant under criteria used by **SHPO** (Sections 106/4f) may have been listed due to the significance of certain historic elements or aspects. It may be possible to alter the bridge and still receive a 'no adverse effect determination' by SHPO. If the bridge house design contributes to the historic significance of the structure's designation, then creative solutions must be developed

which meet all programmatic requirements while maintaining the integrity of the design.

INSPECTION

Rehabilitation of existing bridges starts with the inspection process and identification of non-standard features. Locations and causes of water penetration are carefully documented. Modern computerized elements are much more sensitive to the penetration of moisture than the elements they may be replacing. When mechanical and electrical equipment is to be upgraded it is prudent to assure the owner that new elements can be satisfactorily installed in a weatherproof enclosure. Modern standards for life/safety for all types of structures are more stringent than standards used in earlier years. Based on the design criteria established, a check list is prepared to document non-standard features.

DESIGN

During design the choice of materials and prefabricated building elements is established. The location of the operator's house may dictate that the weight is a limiting factor. The construction staging may further limit use of materials such as cast-in-place concrete. The durability and maintenance of materials are also considered in the selection of materials. Cost is a consideration, however more costly alternatives may be justified by life cycle cost analysis or the visual impact of a material.

If concrete is chosen it can often be enhanced through form work, texture and color. Precast elements can be plant fabricated with increased quality control over these aspects. The use of local stone can often tie the bridge to other architectural elements of the locale.

In northern climates insulation is required. In determining the wall section it is important to consider the impact the chosen wall thickness may have on the available floor area. For example in a ten foot by ten foot house, each additional two inches of wall thickness will reduce the available floor area by approximately 6%.

The choice of windows may have a great effect upon the available glazing area. A heavy duty aluminum window frame may reduce the sightlines of the nominal window area by more than 10%, whereas a cold-rolled steel frame may only reduce the area by 5%. Ventilation requirements and accessibility for cleaning may also dictate the choice of windows. Windows can be specified which tilt in for cleaning. It must be cautioned that windows which function well in most environments may fail under hurricane force wind driven rain.

Durable roofs are required on bridge houses. It is recommended that sloped roofs be designed to provide positive drainage in order to minimize damage even with failure of the roof membrane. Internal drains and external leaders can become clogged without maintenance. Terne-coated stainless steel is one of the preferred roofing materials. It is practically indestructible and maintenance free. Furthermore it weathers to a dull gray patina which is compatible with both modern and historic structures.

Providing sanitary facilities on a remote bridge house is a costly item requiring extensive investigation. The first choice is usually connection to local municipal water and sewer

facilities. This can be a costly option even when sources are available. Pipes require expansion joints along the approaches and insulation and heat tracing are required in northern climates. Electric toilets which 'zap' the waste are generally unsatisfactory due to frequent breakdowns and maintenance requirements, especially when not correctly used. Systems with holding tanks and delivered water are often used when access for pumping is available. Low-flush toilets, micro-flush toilets and metered faucets are now in general use throughout the country. Conservation initiatives have increased their availability and reliability. This has increased the viability of the use of holding tanks. Composting toilets are becoming more feasible as wastewater regulations and awareness of pollution have encouraged their refinement. Composting toilets transform waste into compost by aerobic microbe action. These can now be coupled with micro-flush toilets. This water from the toilets must be treated along with 'gray water' from washbasins, and then disposed of or evaporated. Several companies which manufacture the composting toilets now offer evaporation systems for gray water. Composting toilets have been used for some time by DOT's at rest stops in remote locations.

An added consideration for all items specified for a bridge is the effects of vibration. Particularly assure that all hardware is vibration resistant.

Controlling glare in the control house is a significant design issue. Tinted or coated glazing provides some relief. Transparent, glare reducing shades or adjustable blinds should be provided. Dimming lights provides required night vision. No amount of glare control, however, seems to provide proper lighting to view the red and green indicator buttons on new electric equipment.

CONSTRUCTION

The most important issue affecting construction is the fact that more likely than not the house will be built by bridge constructors. Their experience in coordinating the construction of architectural elements may be limited. If not given guidance, their impulse is to first frame the building structurally without coordinating architectural details. It is only then that it is discovered the windows, doors, air conditioning sleeves and so forth cannot be installed. The designer must insist upon a concurrent and coordinated shop drawing submission of all prefabricated units which must be installed in the exterior of the building. Submissions should be accompanied by erection drawings showing details and sequencing of construction. All installation and flashing must be detailed on the construction documents. A consideration should be given to having construction inspection personnel on site which are familiar with architectural work.

CONCLUSION

Although the design of control hoses, gate houses and machinery houses on movable bridges is driven by their function, the aesthetics of the house and how it blends with the bridge and the surrounding area needs to be considered during the design. Alternatives need to be carefully evaluated to develop an effective, durable and constructable design. A well designed house will complement and enhance the aesthetics of a skillfully engineered bridge.