1.1.2.7 Bridge End Panels and Supports - (continued)

From this website, go to “Permanent Automatic Traffic Recorder Stations (ATR’s) Trend Summaries” and select the latest year.

If a prospectus is not available, if the 20-year ADT is not shown and/or if an appropriate ATR cannot be found, contact the Project Leader or Contract Administrator.

Asphalt concrete wearing surface (ACWS) should normally be used on the end panel when the approach is asphalt concrete. If the end panel settles, compensating overlays can be easily feathered onto the existing ACWS. Concrete strength in end panels should be called out in the General Notes.

End panels may be deleted under certain unique conditions. A geotechnical and structural evaluation is required for considering the deletion of end panels and approval of a deviation from standard ODOT BDDM practice is required. The final decision on whether or not to delete end panels shall be made by the ODOT HQ Bridge Section Engineer with consideration to the geotechnical and structural evaluation.

1.1.2.8 Slope Paving/Railroad Slope Protection

Generally, where a roadway passes under a bridge, provide slope paving on the bridge end fill according to Bridge Standard Drawing BR115. Also, consider slope paving where a bridge crosses over a sidewalk or park.

For a highway bridge crossing over a railroad, rock slope protection may be required on the end fill slope under the bridge.

1.1.2.9 Other Things to Keep in Mind

In this section:

1.1.2.9.1 Structure Appearance and Aesthetics

Keep in mind the structure appearance with respect to its surroundings and the context of the site.

Generally for bridges, appearance is best when elements are few and simple.

Aesthetics and environmental considerations may have apparent conflicts. Historic or environmental issues may impact the bridge rail type, structure configuration, type of foundation or bent placement. Start the permit application and coordination process for historic structures as early as possible in the design stage. Aesthetics concerns, especially within an existing documented site context, are valid issues that can and should impact resource agencies permitting considerations.

1.1.2.9.1 Structure Appearance and Aesthetics - (continued)

Bridge elements are pleasing when the structural intent is clear with respect to the size and shape of the element. Elements forced into a non-structurally responsive shape for decoration are not considered pleasing aesthetically and may be a significant distraction and a safety hazard. Decorations on bridges that are not part of the structural support system may not be maintained to the same level as the structural portions of the bridge unless a separate IGA is executed with a local agency for maintenance.

ODOT has no general directive or mandate on aesthetics or aesthetic design. This section is a guideline to generally accepted practice.

There is a misconception that improving appearance always costs more. This is not necessarily true. The challenge to the engineer is to use creativity and ingenuity to improve the appearance without increasing cost. When people think that improved appearance is going to add costs, they are generally thinking in terms of add-ons, special ornamental features or special colors. The greatest aesthetic impact can be made by the structural elements themselves. These are seen first, and at the greatest distance. The bridge can be made attractive if these major elements are well shaped, and if they fit in well with the surroundings.

The following topics are commonly known to assist in producing visually pleasing structures. They are discussed in more detail in the following sub-sections.

- Location and surroundings
- Horizontal and Vertical Geometry
- Superstructure Type and Shape
- Bent Shape and Placement
- End bent Shape and Placement
- Parapet and Railing Details
- Colors
- Textures
- Ornamentation

LOCATION AND SURROUNDINGS

When determining the appearance of a bridge, the bridge must be considered in context with its surroundings. Decisions need to be made regarding what color, shape and type of bridge will look best at a given location. The surrounding area may be industrial, urban, or rural. A bridge that looks pleasing in a rural setting may look totally out of place in an urban area.

Individual bridges that span a major land area or body of water, because of their large size, dramatic location, and carrying capacity, will tend to dominate their surroundings. While these structures must harmonize with the surroundings, their importance and size requires that the aesthetic qualities of the structure stand on their own. Multiple bridges seen in succession create a cumulative aesthetic impact on the landscape that must be considered. In these situations, there is more reason for uniformity, and there should be no noticeable differences between structures, without an obvious reason. A specific theme for a particular route, such as a parkway, is often appropriate.

Routine bridges, such as highway overpasses and stream crossings, should be simple, with minimal changes, and with all of the elements in clear relationship with one another. Since many of these bridges are viewed in elevation by those traveling on a roadway below, the structure type, span lengths, and proportions, as viewed in elevation, should be carefully considered.

Bridges that are infrequently viewed, such as those on lightly traveled roadways, are rarely seen by anyone. In these cases, attention to the elements that can be seen from the roadway surface such as parapets, railings, transitions, and road surface, are important.

1.1.2.9.1 Structure Appearance and Aesthetics - (continued)

HORIZONTAL AND VERTICAL GEOMETRY

Geometric design standards often dictate the orientation of a bridge. The emphasis is on the need for safe, convenient driving and providing a more attractive highway system. Bridges must adapt to the highway alignment. Thus, they often lie within the curvature of the road and follow the slopes or curvature in elevation. Large curvature is not only desirable from a safety standpoint, but also for aesthetics.

With skewed structures, when it is necessary to orient the substructure parallel to the feature crossed, a wide bridge presents a greater visual impact. The use of natural surfaces that blend in with the surrounding environment may lessen the visual impact. Bents and end bents in waterways that lie parallel to the river's banks look better than those placed perpendicular to the crossing road.

If an alignment requires a curved bridge, then the external longitudinal lines, traffic barriers, and fascia lines of the structure should follow the curved centerline to provide a smooth visual flow. A smooth transition helps the structure fit in with the local topography. Parallel lines should be maintained by matching barrier, sidewalk, curb and fascia depth across the structure.

SUPERSTRUCTURE TYPE AND SHAPE

The appearance of a bridge is greatly influenced by different aspects of the superstructure. These include the superstructure type, depth, overhang width, number of spans, and span lengths. One way to make the structure light and slender, without making it appear weak and unsafe, is to use a favorable visible slenderness ratio (the ratio of span length to the visible structure depth, including the decking and any concrete traffic barrier or steel railing). The typical visible slenderness ratio will vary from approximately 10 to 40 depending on the type of superstructure chosen.

A girder depth that is too shallow gives the appearance that the bridge is not structurally safe. A girder that is too deep makes the bridge look bulky and overpowering. Bridges with a well-proportioned slenderness ratio denote strength without excessive materials.

An additional guideline that enhances the appearance of multiple spans is to avoid changing girder depths from one span to another. This would give a very awkward appearance and would not allow the structure to flow evenly across the bridge. From an aesthetic standpoint, deck overhang should be proportional to the girder depth; a desirable overhang would be about 2/3 the girder depth. Vertical stiffeners make steel girders seem heavier, and should be avoided on the fascia side of fascia girders. Haunched girders can make a bridge look more slender, and help demonstrate the flow of forces in the bridge. Fishbelly girders create a heavy look, and could tend to look awkward. Some structure types are more visually elegant than others, such as trapezoidal box girders and concrete segmental bridges. An arch bridge is one of the most natural bridge types, and generally considered one of the most pleasing. Both thru and deck arches can be considered.

BENT SHAPE AND PLACEMENT

The visual impression that a person gets from a bent is primarily influenced by the proportions, the relative width and height, and the configuration of the bent cap with respect to the bent columns. Bent proportion, in turn, is determined by the bridge geometry and superstructure type and shape. Bents can broadly be classified as either short or tall. Short bents are typically more difficult to design with aesthetic proportions. Care should be taken in proportioning a bent to make sure that horizontal lines of the superstructure are not interrupted. Large bents may direct attention away from the superstructure. Bents that are too slender may convey a feeling of instability.

1.1.2.9.1 Structure Appearance and Aesthetics - (continued)

However, there are aesthetic issues that are common to all bent types involving the shape of the columns and the bent caps. The selection of the proper bent type can be dictated by the site, bridge geometry and design considerations.

The shape and location of the columns affect the appearance of the bents. The light reflecting from the surface often controls how the viewer perceives it. A square or rectangular column with beveled corners will appear more slender due to the edge lines and varying shades of reflected light. The designer needs to assure that the treatments used are in harmony with the rest of the structure. Bent caps, cantilevered ends, and column spacing can be designed to make the bent appear more graceful. For hammerhead bents, the stem width and height, and the cantilever length and depth should be carefully balanced, and in pleasing proportion. Solid bents can be battered to improve their appearance. The batter should be determined by the bent height and the relative dimensions at the top and bottom of the bent. Gradual lines are important. While tall bents are less common than short bents, they allow a greater opportunity for aesthetic treatment.

END BENT SHAPE AND PLACEMENT

For most simple span bridges and some multi-span bridges, the end bents are the most visible elements. While the end bent's function is to support the superstructure and transfer loads to the ground, it is important to maintain proper proportion in order to create a good appearance.
Good proportions between various elements of the bridge give character to the bridge. For the end bents it is important to consider the relationships between the exposed end bent height and length, the size and type of wingwalls, and the superstructure depth. An attempt should be made to achieve a balance between these elements.

The designer must maintain order between the lines and edges of the structure. Too many lines, or lines that are close to but not parallel to each other, can disrupt the eye and diminish the appearance of the bridge. The monotony of a large flat wingwall can be broken up using textures such as scoring, recessing, or grooving. Surface textures, either by using or simulating natural stone around the area of the bridge, can be used to integrate the structure with its surroundings.

The orientation of the end bents to the feature crossed will create different visual appearances. End bents on severe skews can have very long stems and wingwalls. Consideration should be given to the aesthetic impact of those concrete surfaces. Wingwalls are often very predominating features. The orientation of the wingwalls allows for more or less visual impact. On divided roadways, the view presented from the opposite direction of travel should be considered.

PARAPET AND RAILING DETAILS

The railings or barriers, along with the deck fascia and fascia girders, are sometimes the most dominant visual aspect of the bridge. The railings are viewed by people traveling under the structure who see them in elevation and by people in vehicles on the bridge traveling parallel to them. When vehicle speeds are high, the railing or barrier should have simple and pronounced details because passengers cannot notice fine details. The shape of the railing or barrier system should relate to its function and the overall aesthetic design of the bridge.

The design and appearance of any fencing to be placed on the bridge should be consistent with the railing or barrier system. The vertical supports of the screening should align with the railing post spacing. Fencing on concrete barriers should be detailed to match the construction joints and the ends of the barriers.

1.1.2.9.1 Structure Appearance and Aesthetics - (continued)

COLORS

When there is a reason to color the concrete, steel, or railings, a decision should be made whether the color should complement or contrast with the surrounding environment. Strong consideration should be made to the fact that colored concrete or steel will require a high level of maintenance. The designer should also consider the appearance if regular maintenance is not performed (e.g., peeling paint, rust spots, etc.).

Coloring agents are not allowed in concrete because of complicated quality control, difficulty in matching colors in each batch, and the high cost of materials. It is nearly impossible to get an identical color of concrete from one pour to the next, or over a period of time between placements. Staining concrete can create a mottled appearance when appropriate to match natural stone, and can be effective if a trial section is used to qualify the process. External coatings are allowed, and when applied correctly can achieve the desired appearance. However, they have durability limitations, and must be used with caution due to concern regarding the owner's ability to maintain the coating.

TEXTURES

Texturing concrete can be achieved through form liners, panels, stone or brick veneer, or acid washing. Any texturing should fit in within the overall design and proportions of the structure.

Several types of commercial form liners are available. Natural stone or brick facades can also be used. Stone is most often used for parkway bridges and those in rural settings. The cost of stone covering can be quite high; and should therefore be limited to areas of high visibility and established contextual settings. When a concrete cap is used on the top of a wingwall or retaining wall, it should be visually proportioned to the wall itself.

ORNAMENTATION

Ornamentation can be added to a bridge in special circumstances. The additional cost of add-ons is rarely justified except in cases of importance to the community (such as a gateway to a city) or of historical significance. Details such as ornamental light posts, columns or pylons, real or simulated gatehouses, commemorative plaques or reliefs may be added. The designer should consider these details carefully since it is just as easy to detract from the overall appearance of the bridge, as it is to improve it.

Such details are secondary to the primary purpose of the structure, which is to provide a safe and efficient crossing to the public. Ornamental and non-structural details require additional coordination, sketches and drawings to ensure that the details will add to the aesthetic characteristics of the structure in a way acceptable to all concerned.

Local stakeholders sometimes request ornamental screening and features on overpass structures to showcase local attractions as a gateway to their community. Ornamental protective screening should not be a distraction to drivers, and must not cause sight distance or clearance problems. Treatments must not reflect a commercial interest. See section 1.4.4.5 for additional screening requirements.

1.1.2.9 Other Things to Keep in Mind - (continued)

1.1.2.9.2 Traffic Handling and Data

Consider the various methods of handling traffic:

- Is the method proposed by the field the most reasonable way to build a project?
- Are there alternate and possibly more satisfactory solutions?

There are four basic methods of handling traffic when replacing a bridge:

- Close the highway while removing and rebuilding the bridge.
- Use the existing roadway and bridge while constructing a parallel bridge on new alignment.
- Construct a temporary detour around existing bridge and replace the bridge on the existing alignment.
- Use stage construction with one or more existing or new lanes carrying traffic while other portions of the existing bridge are being removed and rebuilt.

Often the last method is recommended over the second and third methods without proper investigation. Stage construction may:

- Cause a high number of complaints from the traveling public.
- Mean greater danger for ODOT and contractor personnel as well as to the public.
- Result in construction difficulties and longer construction time.
- Adversely affect the quality of the finished product.

Another traffic handling consideration that should not be overlooked is accommodating pedestrians (including the disabled) and bicycles passing through the work site, especially in urban areas.

1.1.2.9.3 Bikeways

Oregon law requires that reasonable amounts of highway funds be spent for bicycle and pedestrian facilities. That means: consider bikeway staging needs wherever highways, roads, or streets are being constructed, reconstructed, or relocated.

"Bikeway" is a general term meaning any road or paths open to bicycle travel regardless of whether it is designated for bicycles or to be shared with pedestrians or automobiles. Specific types of bikeways are:

- Bikes lanes or bike paths.
- Shared roadways.
- Shoulder bikeways.
- Sidewalk bikeways.

To work with bikeways, you are going to need:

- *Oregon Bicycle Plan.*
- AASHTO *Guide for the Development of Bicycle Facilities.*

1.1.2.9 Other Things to Keep in Mind - (continued)

1.1.2.9.4 Protection of Recreational/Cultural Resources

Be alert to the effects of construction on:

- Recreational activities, areas, or facilities.
- Cultural resources such as fossils, artifacts, burial grounds, or historical bridges and dwellings.

Refer to Section 00290, "Environmental Protection", specifically Section 00290.50, "Protection of Cultural Resources", in the *Standard Specifications for Construction.*

Although normally researched and proposed by ODOT's Environmental Section, protection or consideration of these activities or resources can be initially overlooked. Permit requirements from agencies like the U.S. Army Corps of Engineers or Oregon Department of Fish and Wildlife deal with historical, cultural, and recreational concerns too. Here are some examples of challenges from the past:

- Protection of summertime river rafters passing under a contractor's work bridge.
- Removal of large amounts of river debris hung up on cofferdams and endangering a collegiate racing crew practicing downstream.
- Saving of old or rare trees near a city bridge construction site in deference to neighborhood sentiment.

1.1.2.9.5 Right-of-Way

This provision is only applicable to new structures and the widening of an existing structure.

Proposed and existing right-of-way limits and any construction easements should be included with the vicinity map information. Ask yourself: Can my structure and the contractor's operations (work bridge, shoring, falsework, future inspection and maintenance staging areas, the potential need for a detour structure, etc.) be accommodated within these limits, as well as safely ingressing and egressing to and from the highway system by agency personnel?

In order to assure the bridge inspectors and bridge maintenance personnel have a safe place to park vehicles and stage maintenance operations, behind the approach guardrail, the bridge design engineer is highly encouraged to provide the desired space by following the "Establishment of Variable-Size recovery Areas" and "Widen Post-to-Hinge Point Dimension" guidelines as provided in Section 5.8 of the ODOT Highway Design Manual ("www.oregon.gov/ODOT/HWY/ENGSERVICES/"). The option that provides the most space is the preferred option. If the structure is located over another roadway, additional parking/staging space should also be considered behind the undercrossing route railing. In order to provide a safe ingress and egress from the highway system, the bridge designer is encouraged to locate these areas behind the trailing end guardrail.

For questions about right-of-way data, contact the project's Roadway Designer, who is in touch with the Right-of-Way Description Group and Right-of-Way Services personnel in the Regions. Both the Location Narrative and the Right-of-Way Estimate Report included in the location survey data package discuss right-of-way provisions and concerns.

For the structure project that does not involve roadwork, verify that steps to acquire necessary right-of-way have been initiated.

1.1.2.9 Other Things to Keep in Mind - (continued)

Anticipate any need for additional right-of-way as early as possible because of the long lead-time required for purchasing right-of-way.

1.1.2.9.6 Utilities

As an early design task, determine if there are:

- Requirements for carrying existing and future utilities on bridges.
- Requirements for accommodating utilities in the vicinity of box culverts, sound walls, or retaining walls, especially mechanically stabilized earth (MSE) walls.

If you are providing for existing or future utilities on a bridge, read Section 1.4.7, “Utilities on Structures”.

1.1.2.9.7 Use of Salvage Materials

New materials are required for new and replacement bridges, and for added portions of widened bridges. ODOT Bridge Engineering Section does not prefer the use of used bridge items. Incorporation of used materials requires a BDDM Deviation approved by Bridge Section. The following are issues to be considered and included in a Deviation Request.

1. Locate and include in the project records for the new bridge all original material certifications and documentation of materials properties.
2. Document the condition of the used materials
3. Locate and include a copy of applicable portions of the original calc book in the project records for the new bridge. The copied portions may be scanned and transmitted electronically to the design engineer. Hard copies should be made and included in the calculation book for the new bridge.
4. Prepare a new calc book for the new bridge.
5. Document agreement from FHWA (on Federal projects) with a Public Interest Finding processed through Roadway Section.
6. Designate on the new plans the portions of the new bridge that are built with salvaged materials.

1.1.2.9.8 Railroad Considerations

When scoping bridge repair work above or adjacent to Union Pacific Railroad right-of-way, consider the following items that may be required:

1. A plan review by UPRR’s engineering folks in Omaha. Expect a thirty working day turnaround.
2. Crash wall addition. This would add approximately $250,000 for each wall.
3. Drainage review.
4. Protective fencing
5. UPRR will want reimbursement for their involvement in the preliminary review work.

1.1.2.9 Other Things to Keep in Mind - (continued)

UPRR standards require crash walls if a pier, foundation or abutment is within 25 feet of an existing or future track centerline. Protective fencing is required on all bridges. ODOT maintains its own drainage. UPRR acknowledges existing construction and maintenance agreements, and will consider this for each review. Minor repair work will not warrant the safety upgrades to the bridge. The ODOT Railroad Liaison should be consulted early in the process for any structure work that could trigger these requirements.

1.1.2.9.9 Bridge ID Paddles

Statements:
The bridge identification paddles are to be installed at the bridge site by the contactor as a part of the construction project. The bridge ID paddle placement location will need to be noted on the bridge rail contract plans and incorporated into the special provisions.

Mount the Bridge ID Paddle on a roadway delineation post and attach it to one of the posts as shown in "Alternate 2 on Standard Drawing TM570, in the bridge rail transition section. Place the ID paddle at both ends of the bridge, facing on-coming traffic. If the structure is located over another route, place an additional bridge identification paddle on the face of the bridge bent, immediately adjacent to and on both sides of the under-crossing roadway, facing on-coming traffic.

Each ID Paddle will be configured in accordance with example and contain the following information. Do not show the dimensions of the paddle in the contract plans or the special provisions in that it is controlled by the ODOT Sign Shop:

- Telephone number of the appropriate agency Dispatch Center
- US or OR Route Number
- State Highway Number
- Milepoint Number
- Bridge Number
- Name of the Structure

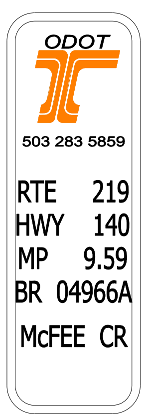

Figure 1.1.2.9.9A

The bridge identification paddles can be ordered from the ODOT Sign Shop:

ODOT Sign Shop Supervisor
455 Airport Road, SE,
Salem, Oregon 97301
Ph. (503) 986-2835

1.1.2.9.10 PERMITS

1.1.2.9.10.1 Permit Applications - If your bridge is over water or a railroad track, you will probably be involved in the permit application process. Even if no permit is required for a waterway crossing, restrictions or comments from the permitting agency may have to be shown on the contract drawings or stated in the special provisions. Always review Part 2 (Appendix Figure A2.2.2.1C) of the Project Prospectus for early indications of possible permit requirements. And then there is the rare situation of an interstate river crossing into Washington and Idaho. If ODOT is the contracting agency, we may need to apply for permits required by the other state.

1.1.2.9.10.2 Three Major Permits - Basically, the Structural Designer is directly involved with supplying information for three types of permit applications:

- U.S. Corps of Engineer/Oregon Division of State Lands (DSL) joint permit application (federal/state waters) submitted by the Permit Liaison of the Roadway Engineering Section.
- U.S. Coast Guard permit application (navigable waters) also submitted by the Permit Liaison.
- Rail Crossing Order (formerly PUC permit) for railroad crossings processed by the Rail Safety Unit of the Transportation Development Branch.

There is a special permit, which does not fit into one of the major permit categories. Before using in-water blasting (for example: keying footings into streambed rock or removing an existing bridge pier), the contractor must have a permit from the Oregon Department of Fish and Wildlife. The contractor will have to submit a Blasting Plan before attaining this permit. Be sure the project special provisions spell out:

- That such a permit is required.
- That adequate lead-time is required to process the application.
- Where contractors can get application information.

Much of the information supplied for permit applications by the Bridge Section is in the form of drawings with specific data shown. TS&L plan-and-elevation drawings and vicinity maps are normally used as a basis for special permit drawings, but they should be stripped of any information not needed to obtain the permit. Keep in mind: the people reviewing the applications are probably not structural designers. They do not have time to sift through many drawing details and dimensions not relevant to the permit approval.

For Federal-aid projects, permits should be in hand 6 to 7 weeks before the bid opening. Usually, FHWA will not usually approve a PS&E submittal without all required permits issued. For other classes of projects, the absolute deadline is the advertisement date or three to four weeks before the letting date.

The need to supply the required permit information as soon and as accurately as possible cannot be overemphasized. Some applications take 6 or more months to get approval. Drawings and any draft special provisions required for Corps of Engineer/DSL permit applications are asked to be submitted to the Permit Liaison, Roadway Engineering Section, 21 to 24 weeks in advance of the project advertisement date. An application returned for missing data can be a scheduling disaster! (See also the third paragraph of Section 2.3.2.1, “Structure Appearance and Aesthetics”, for another benefit of early-bird involvement.)

So, if you are involved with one of the major permits just described, you can find a Bridge Section’s *Bridge Permits Manual* in your Team library.

1.1.2.9.10.3 Other Permits - You should be aware of several other types of permits that may be required for structure projects, even though you may not be directly responsible for furnishing application information:

From ODOT Highway Design Manual Section 10.9 :

ftp://ftp.odot.state.or.us/techserv/roadway/web_drawings/HDM/Rev_E_2003Chp10.pdf

- Permits issued by canal, diking, and irrigation districts. These are the responsibility of the Region Location Engineer or designated representative of the Region Engineer. The Region Utility Specialist handles canal crossings in coordination with the Railroad and Utility Unit in Salem.

- Floodplain permits issued by cities and counties. Region personnel also secure these permits. (See Chapter 1, ODOT *Hydraulics Manual* for background on floodplains.)

- Utility permits. Issued to utility companies by the Permits Unit of Operations Support Services. The permits allow the installation, relocation, and removal of utilities within the State right-of-way.

- National Pollutant Discharge Elimination System (NPDES) permit. ODOT is required to have an erosion control plan for projects with five or more acres disturbed by construction activity. The project Roadway Designer develops the plan with input from several other ODOT sources including the Hydraulics Units.

1.1.2.9 Other Things to Keep in Mind - (continued)

1.1.2.9.11 Bridge Security Design Considerations

Potential bridge security threats include, but are not limited to: “carried and placed” bombs, vehicle bombs, intentional vehicle or ship collisions, intentional fires, and other intentional and unintentional threatening activities. This section tells when and how to consider potential bridge security threats during the design of:

- New bridges.
- Bridge widening.
- Bridge rehabilitation projects.

Deter, Deny, Detect, Defend

Countermeasures can help protect bridges against potential security threats. The four countermeasures to protect structures are to deter, deny, detect, and defend.

Deter: Prevent an aggressor from attacking the bridge by making the security presence known such as police, or other authorized personnel.

Deny: Prevent an aggressor from entering an unauthorized zone by a physical barrier such as security fencing, secure hatches and locked doors.

Detect: Observe unauthorized personnel in a restricted area by means such as cameras, and sensors.

Defend: Hardening measures to protect a component from attack.

Process

First, assess the probable bridge specific security risks

- Remote,
- Possible,
- High, or
- Critical

Remote – implementation of security measures probably not warranted. These are structures located on remote, low volume ADT structures.

Possible – consider implementing measures associated with Deterring and/or Denying Access like limiting Public access to any bridge should be limited to the traveled way. Ideas to consider include, but are not limited to:

- Locate box girder access openings away from abutments so the soffit requires a ladder or other mechanical means to gain access
- Provide shielded locking mechanisms on all access openings.
- Place secure screens at soffit vents near abutments.
- Prevent access to girder flanges and maintenance walkways at abutments.
- Post warning signs on the bridge approaches and below the structure.
- Deny access to critical structural components.
- Prevent vandalism, Graffiti Artists, or Homeless Condos

These structures are located on the non-freeway State Highway System.

1.1.2.9.11 Bridge Security Design Considerations – (continued)

High – consider implementing measures associated with Deterring, Denying, Detecting, or Defend the structure. In addition to the items listed under the "Possible Security Risk", include the following:

- Establish guidelines for standoff distance
- Eliminate access to small confined spaces.

These structures are located on the Interstate Highway System.

Critical Structures – These are those structures that have been determined to be the most vulnerable structures in the State of Oregon.

Some bridges, due to their complex and unique nature, will require project-specific countermeasures along with those countermeasures that apply to all bridges. These are bridges considered "critical" to the transportation network. The most critical bridges will also require site-specific operational security plans. The ODOT Emergency Preparedness Committee identified critical bridges and their potential vulnerabilities. To find out more, contact the Statewide Emergency Operations Manager in the ODOT Office of Maintenance and Operations.

The need for security countermeasures should be considered during the project scoping phase, to ensure that added costs are included in the project budget. Countermeasures and security plans should be defined and included no later than the Type, Size and Location submittal. The Project Design Team should consult with the ODOT Bridge Operations Engineer for security guidance and to maintain consistency statewide.

If the ODOT Bridge Operations Engineer decides a critical bridge needs specific mitigation measures, consider these strategies first:

- Locate piers and towers so vehicular access is prevented
- Design redundancy with critical elements.
- Place barriers to provide **standoff distance** when critical structural elements cannot be located away from vehicular traffic. If this cannot be achieved, the critical structural member or mechanical system should be analyzed and hardened against the design threat.
- Install locks, caging and fencing to **deny access** to key points of vulnerable structural and mechanical systems.
- Install motion detectors or security cameras and plan for communications to security response entities to **minimize "time-on-target."**

Next, when cost-effective, consider selective protection of the structural integrity of key members against collapse. Ways to do this include strengthening key substructure members, adding redundancy, and use of blast hardening.

Again, project-specific countermeasures should only be considered for those structures which ODOT management decides need specific attention during the design phase.

1.1.2.9 Other Things to Keep in Mind - (continued)

1.1.2.9.12 ODOT Accelerated Bridge Construction (ABC) Guidelines

Introduction

Oregon has employed ABC methods to quickly deliver several bridge projects throughout the State. From the compiled list of 15 projects that had used ABC bridges to date, two-third of them was completed in the past five years. Depending on the types and locations of the bridges, several different techniques were used. Some of those bridges were assembled or erected on temporary falsework located adjacent to an existing structure using prefabricated elements and systems and skidded into place. This method allowed the contractors to close the facilities to vehicular traffic for a relatively short time (like over a few days or weekend) and skidded the bridge over after quickly demolishing the existing bridge at night and working throughout weekends. Other bridges over navigable waterways were replaced using barges to float new and whole superstructures into place, also known as switch-out with the old structure if one existed. For wider structures that can accommodate staged construction, precast concrete or concrete filled, steel grid deck panels were installed during partial closure of the roadway during off peak travel times.

A few of the Oregon ABC projects were designed with rapid construction in mind to limit traffic interruptions, but most were selected either based on VE proposals by contractors, incentive/disincentive provisions, or design-build contracts. Generally the project schedules specified a relatively short period window for closing or disrupting traffic operations on the facilities. The incentive/disincentive provision for each project was normally based on user delay costs as a function of ADT, detour length and other variables. Those projects have demonstrated ABC as effective and efficient solution to alleviate congestion and/or long detours where conventional methods such as off-site detour, on-site detour, stage construction or slight realignment of the roadway were difficult or not feasible. They resulted in improved public safety through the shortened work zone exposure and supported mobility.

ODOT encourages and supports ABC Projects

ABC methods can be defined as using prefabricated bridge elements, combining elements into systems, or moving a complete bridge span to quickly deliver a project and re-open the highway to traffic. Use of any of these methods are encouraged and supported by ODOT whenever it is efficient and cost effective. A compiled list of past Oregon projects that described the ABC featured elements is provided here at the end of the Section for reference.

Prefabricated elements consisting of deck panels, beams or girders, bent caps, pier columns and segments have been demonstrated successfully. Systems may consist of bridge components assembled and connected together to form a major portion or complete bridge span. Bridge movements such as incremental launching, skidding, and/or transport by self propelled modular transporters (SPMT) of a partial/complete superstructure span are also found to be acceptable methods of construction. The guidance provided here below will help designers and owners decide when and where ABC is appropriate as a method of project delivery. Although the Engineer on Record is responsible for the design as well as for developing a unique method of construction/movement to fulfill the ABC requirements, the owner needs to be assured that the quality and durability of the bridge is not being compromised by the specific rapid construction technique being considered.

Contracting Methods Allowed

A contract for specifying ABC method of delivery is allowed and will continued to be allowed under the current design-bid-build specifications. A contractor may propose an alternate method of construction for approval by the EOR/owner as part of the Cost Reduction Proposal provisions in Section 00140.70 of the Oregon Standard Specifications for Construction. The third option allowing ABC is provided under the design-build contract provisions. More discussions and guidance are provided elsewhere and will not be elaborated here.

1.1.2.9.12 ODOT Accelerated Bridge Construction (ABC) Guidelines - (continued)

Decision Making Framework

A successful ABC project is dependent on deciding correctly at the beginning of a project planning to assess when and where ABC would be most efficient and effective. The following criteria in the flowchart, Figure 1.1.2.9(10)A, for specifying a short window of closure may make ABC delivery the method of choice:

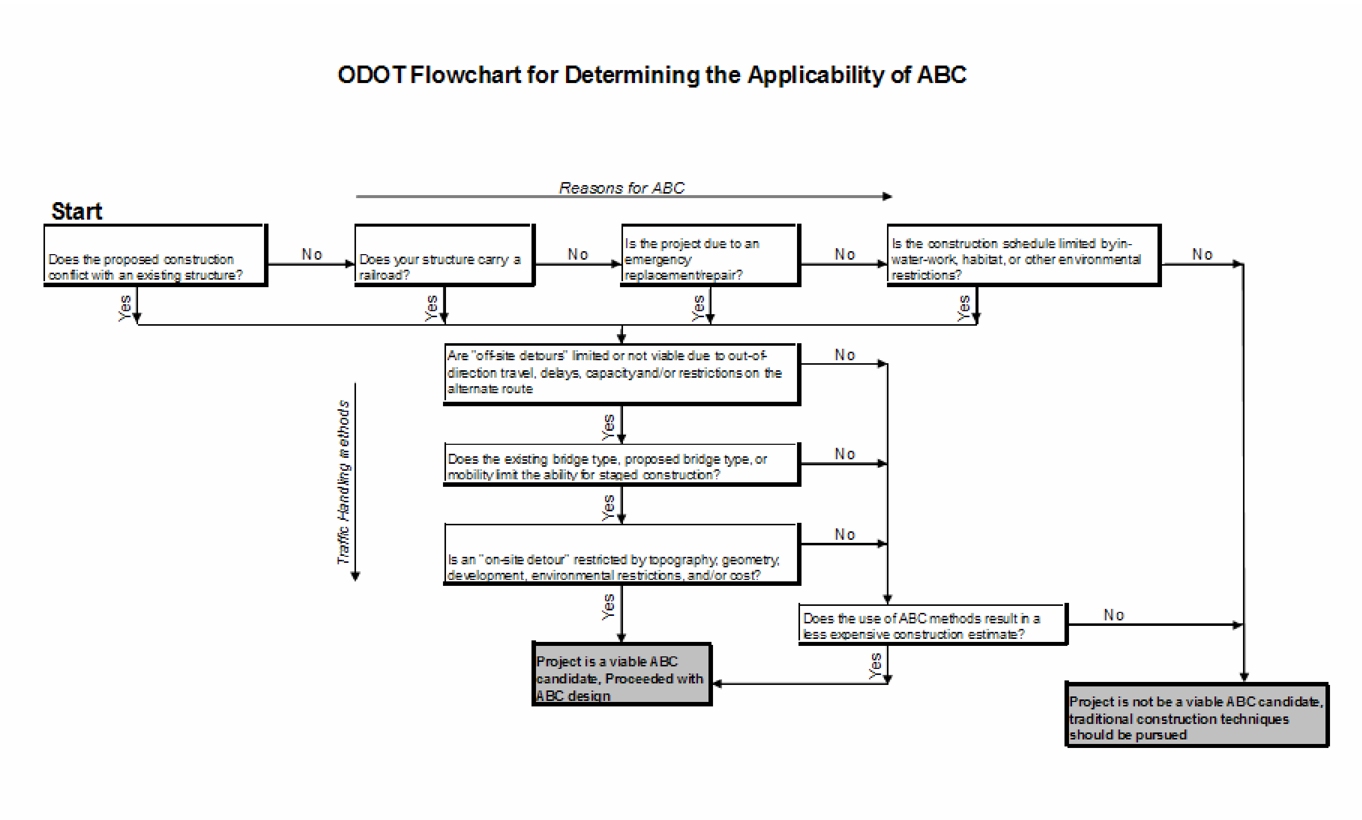

Figure 1.1.2.9.10A

1.1.2.9.12 ODOT Accelerated Bridge Construction (ABC) Guidelines - (continued)

A following matrix format presents more discussions between selecting an ABC versus a conventional project for the various attributes:

ATTRIBUTES	Accelerated BC (ABC)	Conventional BC (CBC)
1. Complexity	-Engineer less familiar with design required for accelerated bridge construction techniques -May require more surveys to establish control points -May require pick points for prefabricated bridges -May require more complex construction techniques -May need new specs -May add risk to Contractor -May require special equipment -Good with D/B and A+B with incentive/disincentive	-Engineer more familiar with design required for conventional construction techniques; therefore, considered less complex. - Contractors more familiar with methods used in conventional construction, therefore considered less complex -Standard specs exists
2. Schedule	-Facility to reopen for traffic in hours or over weekends -Slightly longer design schedule due to complexity (see above) -Need more overall planning and coordination -Parallel construction off CPM -Typically can be done off-line and shorter field erection season, pending ABC method chosen. -Approach or utility work may control schedule if not outside CPM -Good with incentive/disincentive -Constructible connection details for precast elements such as bent caps, footings & pile heads require flexibility for field closure pours. -May require coordinated demolition plan for change-over structures -May require tight control of scheduling on critical items -The contract plan or designed details should be simple or the precast element detail may not fit. -May require industry participation in PBES/ABC to ensure successful transition to field application. -Include contractor on design or constructability review team.	- Typical field construction season in months or years -Typical design schedule -Often bridge work is controlling in CPM -Sequential activities typical and limitations may exist -Public delay cost may be high
3. Budget	-May be more expensive in construction cost due to non-typical construction on methods -May increase design cost -Limited historical bid item data -ABC can significantly reduce the costs to	-Typical estimate given condition and conventional required structure type. -Typical standard project costs. -Incentives and disincentives may be included to accelerate

	highway users associated with traffic queues and detours during the bridge installation. -The contract bid cost for an ABC project may be more than a conventional bridge project but overall may be much less when the savings due to reduced traffic impacts and delays are factored in.	construction and reduce traffic impacts but they may not be effective and could adversely impact project costs. -Careful analysis is needed to effectively apply incentive/disincentive methods to accelerate bridge projects.
4. Design Quality	Design quality could be just as good as that of conventional -Limited design criteria for some elements -Construction loads may control design and need check -Require to show full connection details	Design quality is expected to be good from standard and best practice.
5. Construction Quality	-Individual prefabricated elements are of higher quality under shop-controlled environment. -Construction quality could suffer in the field assembly due to time pressure.	-Construction quality depends on the contractor and inspection staff.
6. Disciplines required	-May requires more upfront coordination between technical and non-technical disciplines and public relations.	Standard project design and construction teams
7. Experience needed	-ABC experience is desirable especially regarding knowledge of ABC construction methods, new technologies and implementation of new design and details. -Additional research effort and resources may be required. -May require specialty construction experience.	-Standard project design experience. - Standard bridge construction experience.
8.Public Communications	-May require more early and upfront communication with the public for temp/short road closures -May need to develop a communication plan with stakeholders	- Typical
9. Demolition of existing structure	-Require full demolition plan -May need to provide staging place near site for off-line demolition -Coordination for change-over structures -May not require temporary structure to be in place for long duration	-Typical construction with either road closure or requires staging -Require full design of temporary structures for longer duration in place
10. Quality Control	-ABC elements should be verifiable during construction -May require constructability review	Typical
11. Owner Staff	Some additional effort may be expected of the owner staff in design or review of non-conventional details/procedures. Also may require more staff in a much more condensed timeframe.	Standard

Steel Structures

Steel structures are excellent examples of prefabricated bridge elements and systems. They are proven to be cost effective and sustainable for ABC methods. The steel girders are prefabricated and primed coated as needed in the shop and shipped to the job site. A short closure of the affected highway facility may be required to erect them. Several complete arches and trusses have been erected successfully on barges and floated into place.

Bridges built with plate girders (straight or curved) can accommodate precast concrete panels or steel grid deck systems for rapid construction. Some connection details can be found at www.fhwa.dot.gov/bridge/prefab/

Concrete Structures

Prestressed and Precast Concrete (PPC) versus Cast-In-Place (CIP)

PPC bridge elements can be mass produced in PCI-certified plant under factory-controlled conditions to ensure high quality and consistency, thus making them more reliable and durable. The products can also be transported to the jobsite for just in time delivery to meet erection schedules, thus avoiding re-handling or the need for storage space that might be difficult to provide in urban areas. Traffic impact at the project site can be minimized and erection can normally be done during off peak hours.

In Oregon, construction cost for PPC girders has been lower than for CIP girders. Unless there is a compelling reason like curvature, aesthetics, and longer span requirements, PPC girders are preferred. There is an economy of scale for larger projects requiring repetition of similar spans. For elements other than girders, there is an opportunity to develop effective standard elements for connecting them into bridge systems. In the erection of PPC elements, proven connection details are critical for long term performance. ODOT will be looking at collecting and refining these details in the near future. The FHWA has developed a manual on proven connection details routinely used by others and the publication will be available in the near future. See www.fhwa.dot.gov/bridge/prefab/

Full Depth Deck Panels, End Panels or Approaches and Wingwalls

Full depth deck panels have been in practice and continue to be widely used by many states. Connection details for both steel and concrete girder exist. The NCHRP 12-65 study is looking at a new deck system with connection details using conventional reinforced or prestressed technology. More details will be available in the near future.

ODOT has existing standards for end panels/approaches and wingwalls that can be readily converted into ABC.

Precast End Panels

- Consider issues regarding subgrade compaction and the contractors' ability to construct the surface of the subgrade to a smooth level condition prior to placement.
- Consider the ability of precast panels to accommodate differential settlement (especially if subgrade is not level)
- Consider the design of the connection detail to pile cap/abutment wall and any joint construction.

Seismic Related

Assembling prefabricated bridge elements on site, one method of ABC requires a very detailed assembly plan and connection details. Whereas for single span bridges this is not very complicated, designing and detailing of connections for multi-span bridges has to be treated with the same importance as designing the rest of the structure.

Submit new connection proposals for approval to ODOT Bridge HQ. This requirement is intended to ensure information about good connection details are subsequently distributed to other design groups. From the owner's perspective, Oregon DOT has been proactive on researching and participating on several studies and tests of several types of connections. The main focus of this research has been toward the superstructure-to-substructure connections such as pile-to-pile cap connection, bent cap-to-column connection, beam-to-bent cap connection, precast deck-to-girder connection, etc. For low-to-moderate seismic hazard a few good connections applicable for single span bridges and multi-span bridges have been identified. For areas with high seismic hazard, the research and study of connection details for ABC applications is an ongoing process. The NCHRP 12-74 research project "Development of Precast Bent Cap Systems for Seismic Regions" identifies a number of bent cap-to-column details that hold promise for seismic applications. ODOT is willing to implement a few of these details only for bridges in low-to-moderate seismic regions (Seismic Design Category "A", "B", and "C"):

a) Grouted Duct – Grouted duct connections consist of bent caps which have corrugated ducts to accept reinforcement extending from supporting substructure elements.

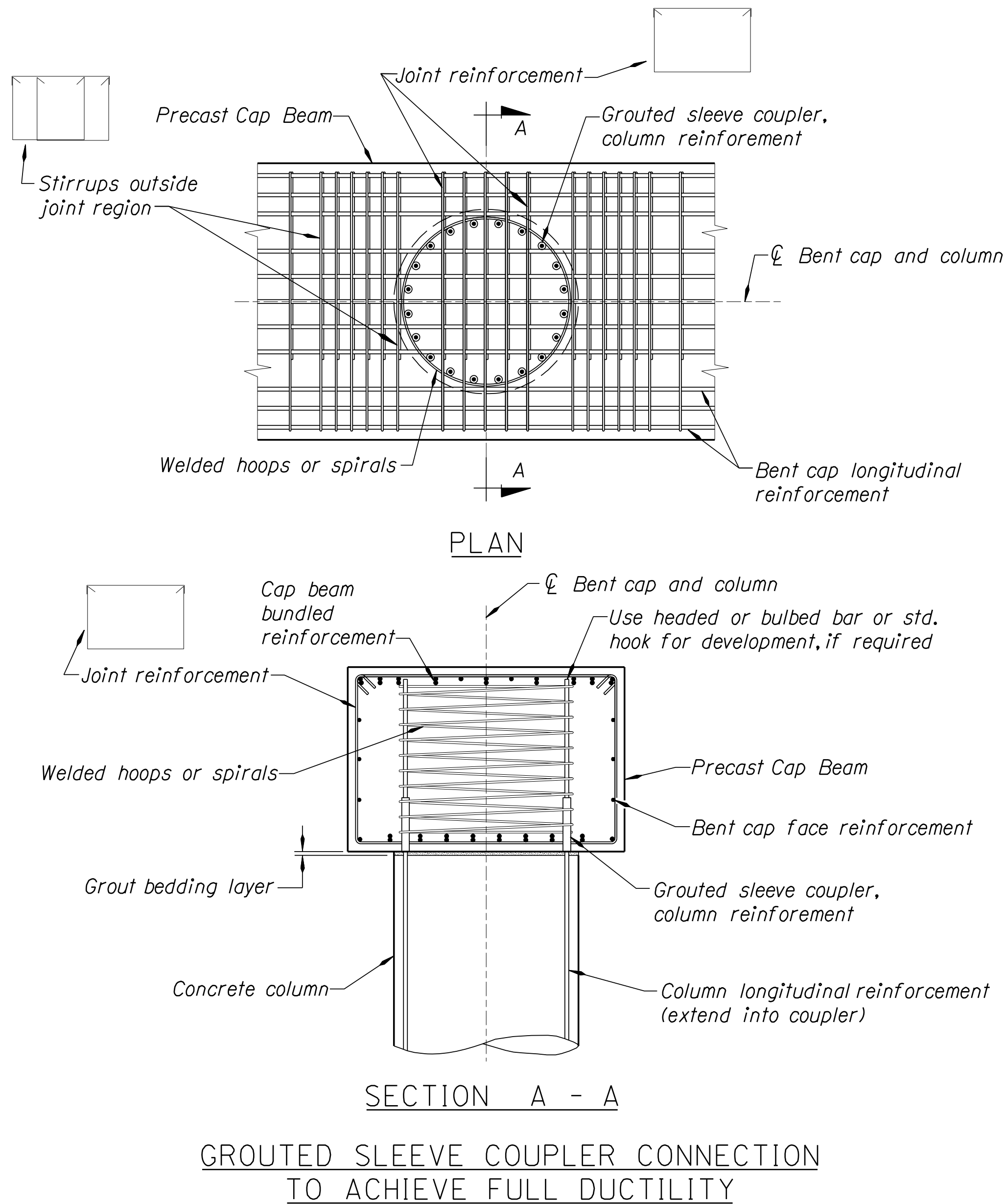

Figure 1.1.2.9.10B

b) Grouted Sleeve Coupler (Coupler in Cap) – Proprietary grouted sleeve couplers are used to connect reinforcing bars in precast concrete components. These couplers are placed in the bottom-half of the precast bent cap and are designed to withstand forces at overstrength as is often required in plastic regions.

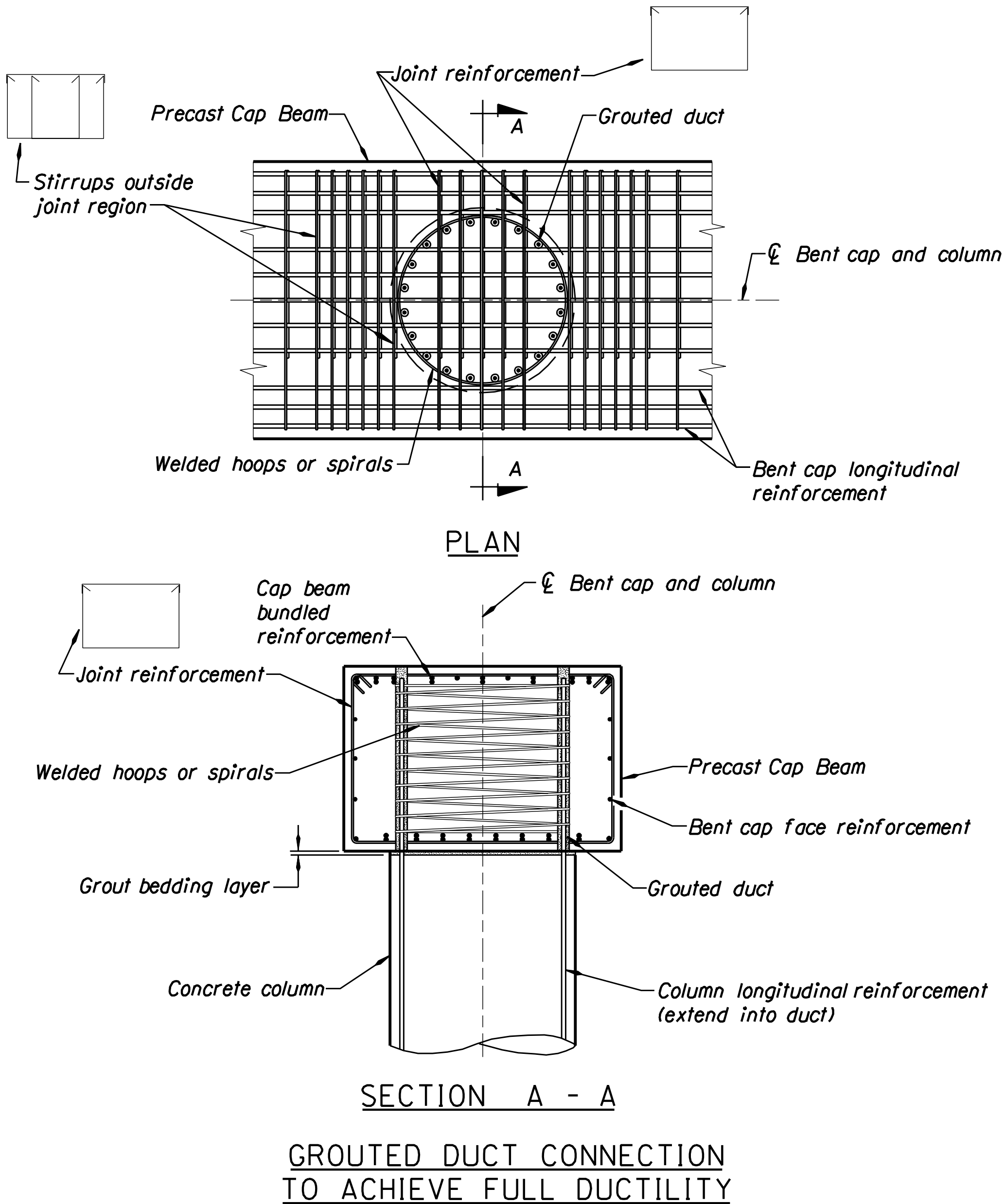

Figure 1.1.2.9.10C

Other research related to seismic connection details under NCHRP Projects are being proposed and considered and more guidance would become available in the near future.

Use of SPMT

A new heavy equipment technology brought back from and promoted by the FHWA/AASHTO Scanning Team known as Self-Propelled Modular Transporters (SPMT) is becoming popular. The SPMT can support and move heavy load with its flat bed mounted on multi-axle, independent suspension and steering wheel lines. They have the ability to maneuver in difficult and uneven terrain with unmatched precision and distortion control of its payload.

Several projects have demonstrated successfully the use of SPMT for moving complete superstructure spans that were prefabricated at a staging area (e.g. gore area or off the shoulders) near the final bridge location and off the travel lanes. The bridge movement was generally done on weekends or night time using the SPMT to erect the structure into their final position within a matter of hours. FHWA has published a user guide manual and it is recommended as a resource document for anyone contemplating to do an ABC project using the SPMT. The guide is available to the public free of charge at http://www.fhwa.dot.gov/bridge/pubs/07022/

Geotechnical Consideration

The foundation designer should consult closely with the bridge designer and the project team regarding the use of ABC methods at a particular bridge site and coordinate these efforts as necessary during the bridge design process.

Usually driven piling is the most rapidly constructed foundation type but piles are not always suitable at every location for meeting specific bridge design requirements. The most suitable foundation type for a bridge replacement or widening project depends on several factors including the subsurface materials and conditions, construction or environmental constraints and cost. Refer to the **ODOT GDM; Chapter 8** for additional guidance regarding the selection of foundation types. Once the most suitable foundation type is selected for a site, thought should be given to how the foundation construction can be expedited. This should include how to minimize traffic impacts due to foundation construction. At some locations the foundations (and substructure elements) may be constructed under, or away from, the existing bridge thereby avoiding, or minimizing, any traffic impacts. If this scenario is possible, then the time required for foundation construction may be less significant because it does not directly affect traffic. At sites where foundation construction will directly impact traffic and multiple foundation types are possible, consideration should be given to the foundation system that can be constructed in the least amount of time and with the least impact to traffic. Some general guidance regarding the use of various foundation systems in ABC applications are described below.

Spread Footings

- Conventional Spread Footings
    - Requires excavation to suitable foundation materials which may result in the need for large excavation areas and/or temporary shoring and possibly dewatering.
    - Requires setting rebar, a concrete pour and curing time (and form work, if needed).
- Precast Reinforced Concrete Spread Footings

  This type of ABC foundation system is currently under development and design and construction standards and specifications do not currently exist. This type of foundation may be considered at sites where conventional spread footings would be appropriate, however, precast spread footings (PSF) are currently recommended only for shorter, single span bridges at this time. Issues to consider in the application of precast spread footings would include:
    - Need for construction of a concrete footing leveling slab beneath the precast footing (excavation/shoring, sloping bearing strata, presence of groundwater, etc.),
    - Design of the connection between PSF and leveling slab,
    - Design of the connection between the PSF and columns or abutment walls,
    - Constructability issues when placing PSF directly on compacted soils,
    - LRFD resistance factors for bearing and sliding resistance based on construction method, and settlement analysis.

Driven Piles

- Often the quickest foundation construction method and can generally have the least impact and disruption to traffic.
- Consider using fewer, higher capacity, piles per bent to expedite construction, however:
  - Using higher capacity piles may result in significantly higher foundation costs due to the need for larger pile driving hammers, leads and cranes and possible effects on the cost of work bridges due to these higher loads.
  - Using less than 5 piles per bent may result in a reduced LRFD resistance factor due to less redundancy
  - May be most appropriate for sites with relatively short end bearing piles.
- Requires assessment of pile top alignment tolerances for precast pile cap connection,
  - Standard specifications (Section 00520.41(f)) allow for a horizontal alignment tolerance of 6 inches from the plan location. If a smaller tolerance is required then this reduced tolerance must be specified in the special provisions. Consult with the project geotechnical engineer regarding allowable horizontal tolerances for driven piles.
  - Should piles be installed in prebored holes to meet the specified tolerances? However, keep in mind the final pile alignment is only as good as the prebore hole alignment. In soils where large cobbles and/or boulders are present, or where preboring will encounter a bedrock unit with a sloping surface, prebored holes should not be augered but instead excavated using core drilling equipment. Augers tend to wander uncontrollably in these materials and borehole alignment is very difficult to maintain.
  - Consider the time and cost of preborings.
  - Consider the risk of not preboring (possibly include preboring as an anticipated item)
- Minimize the potential for in-lead splices, particularly on pile with a wall thickness of greater than 0.50 inches such that extensive welding and welding QA/QC is not required.
- Increasing estimated lengths in variable subsurface conditions will help reduce the likelihood of an in-lead splice for pile shorter than 60'. For longer pile consider specifying that the pile be fabricated (spliced) on site prior to putting in the leads, taking into account the cost of using larger size leads and cranes and other concerns similar to those discussed above when using fewer high capacity pile.
- Piles can be installed in existing travel lanes, in stages under traffic control, and covered over with temporary steel cover plates to keep travel lanes open to traffic until the time for substructure construction.
- At water crossings consider a trestle pile design which eliminates the need for a cofferdam (if an above ground pile cap is permissible). The potential for drift buildup should be assessed relative to the use of a trestle pile system. A web wall may be required if drift potential is significant.

Drilled Shafts

- Usually take the most time to construct, however drilled shafts are often the best method for rapid in-water foundation construction, since they may omit the need for a cofferdam (unless required for environmental considerations),
- Consider fewer, higher capacity, shafts per bent, (*note that appropriate modifications to LRFD resistance factors are required for bents with less than 2 shafts*).
- Higher potential for increased risk of time delays due to problems with shaft construction or negative NDT results

Micropiles

- Usually more expensive than the other foundation types,
- Suitable for certain ground conditions, particularly manmade unconsolidated rock fragment fills and low overhead clearance areas,
- May be installed to tight tolerances and drilled through pavement sections,
- Consider environmental concerns relative to spoils recovery since water is typically used to flush out cuttings.

Accelerated Embankment Construction

The time required for embankment construction, (either an all new roadway embankment or a widening section) depends primarily on the volume of material required, the type of embankment materials used, the level of contractor effort and the subsurface conditions at the site. Other factors such as access, retaining wall construction and weather can also play a role and affect the speed at which an embankment can be constructed. Embankment construction may be accelerated in a number of ways, however in areas where very soft ground conditions exist, and there is potential for significant settlement and stability issues, consideration should be given to extending the bridge structure over these areas. This may result in a better overall design with less environmental impacts and a shorter construction period.

For ABC projects, the geotechnical engineer should evaluate the site conditions and project requirements to determine the most effective way of expediting embankment construction with the least impact to traffic flow and mobility. Refer to **ODOT GDM; Chapter 9** for more design guidance on the analysis and design of embankments. ABC projects often replace bridges in the same location (same horizontal alignment) as the existing bridge, except the new bridge is usually wider and therefore the approach embankments need to be widened. The grade may also be raised resulting in a further increase in embankment widening. Depending on the site constraints (available access/ROW, adjacent structures, wetlands, etc) this widening can often be accomplished with minimal traffic impacts. However, the geotechnical engineer should play a key role in the design of these widened sections to help determine the best approach for expediting the construction while taking all appropriate geotechnical design requirements into account.

The need for retaining walls on a project should be carefully reviewed. Typically an embankment can be constructed much quicker than a retaining wall. Retaining wall needs are typically driven by roadway “typical section” needs that may not have been optimized to reduce the need for retaining walls. For example, the slope immediately behind a guardrail could be steepened from the typical 1V:3H or 1V:4H to steeper slopes if longer (8’) guardrail posts are used rather than the typical 6’ post lengths. Often typical fill slope rates of 1V:2H are considered in typical sections rather than steeper slopes which may omit or reduce the need for a wall. The use of stone embankment material to construct 1V:1.5H fill slopes, and using 8’ metal guardrail posts to assist in penetrating the stone embankment material, has been used successfully on several projects.

Retaining walls may be proposed in some areas to avoid, or minimize, environmental impacts. However, the need for walls in these areas should be closely evaluated, in consultation with the appropriate environmental specialists, to determine the underlying reasons for requiring a wall and whether or not it is the best solution for the specific location.

Some suggested considerations for embankment construction on ABC projects are summarized below:

- Use "All-Weather Materials" (stone embankment) instead of common "borrow" materials where available and appropriate. This allows construction to rapidly proceed regardless of wet weather conditions and can greatly reduce the total embankment construction time.

- Soft Ground Conditions (settlement and stability issues)
    - Lightweight fill material such as geofoam applications
    - Geogrid reinforced embankments
    - Ground improvement techniques
    - Surcharge, with or without vertical wick drains

QA/QC, QUALITY CONTROL FOR PREFABRICATED CONCRETE ELEMENTS

Types – ODOT has used a variety of prefabricated concrete elements on many projects. Prestressed concrete elements have been used since the 1960s. Use of non-prestressed prefabricated concrete elements dates back even earlier. The types of prefabricated concrete elements used on ODOT projects have included:

- Prestressed slabs and box beams
- Prestressed girders
- Prestressed columns
- Prestressed arch ribs
- Prestressed piles
- Bridge railing
- Bridge end panels
- Pile caps/abutments
- Stay-in-place deck forms
- Culverts
- Manholes and utility vaults

Prestressed Elements - When precast concrete elements include prestressing, Section 00550 of the standard specifications apply. 00550.05 requires fabricators to be certified under the PCI Plant Certification Program. PCI certification ensures that industry best practices are followed. The member tolerances specified in 00550.04 are those recommended by PCI.

For non-standard prestressed concrete elements, the existing Section 00550 Oregon Standard Specifications for Construction will likely be adequate without modification. However, the designer may need to create a unique bid item since the available bid items only cover our current standards.

Designers should verify details with local precasters (Knife River and/or R.B. Johnson Co.) before design plans are final. The ODOT Bridge Materials Engineer should also be consulted to verify whether standard inspection procedures are adequate.

Non-Prestressed Elements – Precast concrete elements that are not prestressed should be specified under Section 00540. Since there is not a nationally recognized certification program for non-prestressed elements, the designer will need to determine some minimum qualifications for fabricators. Minimum qualifications may include:

- Submission of a Quality Control Plan
- Names and qualifications of key personnel
- History of similar projects
- Procedure for tracking material certifications

The nature and complexity of the project will determine which items above should be included in the minimum contractor qualifications. Solicit input from the ODOT Bridge Materials Engineer before finalizing any contract special provisions.

In addition to project qualifications, it may be desirable to also require the contractor to identify the form material and forming details. Lifting and shipping details may also be required. For unique lifting and shipping situations and/or large elements, it may be necessary to require verification of lifting and shipping details. Such verification could be achieved with review by a professional engineer or by testing. Especially where there is potential for items to be fabricated by a contractor with little or no experience with precasting concrete, the special provisions should include language that ensures safe and adequate lifting and transport details. In some cases, it may be desirable to add lifting and shipping verification as part of the contractor's Quality Control Plan.

Where precast concrete elements are specified under Section 00540, the designer will need to write a special provision to address measurement and payment. Most structural concrete is paid on a cubic yard basis. However, precast concrete elements should be paid either on a per length basis or per each.

Standard fabrication tolerances for structural concrete are provided in Section 00540.40. These tolerances are based on typical cast-in-place concrete construction. For precast elements tighter tolerances may be achievable and desirable. Consult with the ODOT Bridge Materials Engineer to determine reasonable tolerances for your specific application.

Inspection of precast concrete elements will be required both during the precasting operation and during placement in the field. The ODOT Bridge Materials Engineer is responsible for inspection of precast elements and should be notified when precast concrete elements are to be used. This will help ensure ODOT staff is scheduled to be available for such inspections and whether any adjustment to the ODOT Nonfield-Tested Materials Acceptance Guide is needed.

Connection Issues – Current state-of-the art does not support connection of precast cap elements in high seismic locations. This is currently being researched at the national level.

Connection of precast elements may involve the use of grout pockets to emulate cast-in-place construction. Where grout pockets are used, manufacturer's recommendations should be followed regarding when grout should be extended with aggregate. For many grout products, aggregate is recommended when the pocket size reaches 2 inches or more.

COSTS CONSIDERATION

It has been determined by numerous projects nationally that accelerating a project delivery will reduce the costs to highway users associated with traffic queues and detours during the bridge installation. Utah DOT has demonstrated that ABC can be successful and the initial costs of innovation are absorbed on the first few projects when there is some assurance that more projects using the same technology are being planned for the near future. The use of ABC should be justified on a specific project by analyzing the user cost savings compared to the estimated cost of various methods of rapid construction (see HYRISK discussion below).

ODOT has posted a Work Zone Traffic Analysis Tool that considers such topics as traffic delays and operations, and long detours. Guidance on Incentive/Disincentive Program for designers is also available. See http://intranet.odot.stste.or.us/tsestimating/

Incentive/Disincentive Program

Requirements related to reduced traffic impact and time must be clearly specified in the contract documents. Innovative contracting strategies to achieve accelerated construction include incentive/disincentive, a financial bonus or penalty for delivery before or after a time set in the contract; A+B bidding, cost-plus-time based on the combination of contract bid items (A) and the time bid for construction multiplied by daily user cost (B); lane rentals, assessed rental fees for lanes taken out of service during temporary lane closures for construction; and no-excuse bonus, a modified incentive with no time adjustment for problems such as delays due to weather or utility conflicts regardless of who is responsible.

Incentives and disincentives for early completion give contractors a financial reason to change their conventional practices to accelerate construction. Contractors cannot count on incentives and, therefore, may not reduce their bid price in anticipation of receiving incentives. Disincentives are necessary but may result in higher bid prices because of the risk to contractors that they will not be able to meet the reduced construction timeline. However, in some accelerated bridge project case studies, it was found that by providing the right incentive/disincentive, the contractors were able to lower the overall total project costs when compared to conventional delivery methods.

Maintenance of Traffic Costs

Traffic management and user delay-related costs associated with bridge construction activities will significantly influence the selection of the most cost-effective bridge technology.

Elaborate traffic control plans can significantly add to the cost of the replacement, especially when the traffic control plan changes significantly during the project due to development, local expansion, or other projects in the area. Cost savings from the reduced duration of the traffic control plan through the use of ABC method of delivery can be estimated based on the reduced number of days of traffic control cost times the average daily operating cost of such measures for comparable bridge projects.

Contractor’s Operation Costs

In general, contractors bid projects with the plan to complete onsite construction as quickly as possible to increase profits; this is particularly true for projects with incentives for early completion. The contractor’s costs, including overhead costs to staff projects with construction crews, etc., are reduced when the duration of the construction project is reduced. Also, construction crew safety in the work zone is increased with reduced exposure times related to the construction duration.

Owner Agency's Operation Costs

Agency overhead costs to staff projects, e.g., construction engineering and inspection support, are reduced when the duration of construction projects is reduced. Prefabricated bridges, with their rapid onsite installation, can significantly reduce these project costs.

The use of prefabricated bridges to accelerate construction cannot be approached in a conventional manner by the owner. The owner will need to commit to working multiple shifts, odd hours, and under the same constraints as the contractor.

The manufacturers of the prefabricated components may be able to offer lower unit costs if they can spread their fixed costs over many bridges and/or reuse the formwork repeatedly. The bundling of projects will provide an attractive incentive for a contractor to acquire new or special equipment when he can recoup his investment without pricing his bid out of the market.

Available Tool: HYRISK

How much will it cost highway users if a bridge is closed or detoured? The bridge with the longer detour would require additional time and mileage costs to negotiate the detour, and would incur the most cost to users. When considering the cost of the project, the cost of the construction of the bridge alone fails to capture the total cost of the project.

A method that blends the cost of the bridge construction and captures users economic losses associated with a bridge construction is discussed below using HYRISK algorithm to compute the economic impact to a community.

ADT and detour length are extracted from the NBI record for the bridge. The assumed 2008 cost per distance traveled was equal to $0.44/mi ($0.27/Km). It is assumed that the project would have one year duration of the detour.

Detour Mileage Cost (DMC) = Duration * Length Detour (L) * Cost/Length (CpL) *ADT Sample Bridge Project (Br # 00138)	
Duration of facility for construction (D) in days	365
Detour length (L) in km	26
Cost per Mile per Vehicle driven of detour length (CpL)/km	$0.27
Average Daily Traffic (ADT)	330
Time cost per person (TcP)/hr	$16.31
Occupancy rate (person) per vehicle (O)	1.56
Time cost per truck (TcT)/hr	$29.50
ADTT (Truck Traffic as a percentage of ADT; i.e. 10% this case)	.10
Speed of Traffic on Detour (DS) in km/hr	64
Detour Mileage Cost (DMC) = D*L*CpL*ADT	$845,600
Detour Time Cost (DTC) = D*L*[(O*TcP)*(1-ADTT)+(ADTT*TcT)]	$1.265 M
Total Community Cost associated with bridge closure $T1_{cost}$=DTC+DMC	$2.11 M

1.1.2.9.12 ODOT Accelerated Bridge Construction (ABC) Guidelines - (continued)

Compiled Oregon ABC listing of bridges replaced using ABC techniques.

- OR 38 over Elk Creek Bridges near Elkton – 2 steel plate girder bridges - Built on temporary falsework adjacent to the existing and skidded on tracks over during two weekend road closures (2008).
- OR 38 Bridge over Hardscrabble Creek, Douglas County - Built adjacent to the existing and skidded into place (2008).
- Kimberly Bridge OR19, Grant County – Rapid replacement of two approach spans using precast pile caps on a long structure with 20-day full road closure (2008).
- Depot Street Bridge over the Rogue River (Jackson County) – Concrete arch 306-foot span bridge built adjacent to existing and skidded over. Bridge was closed for 5 days total (2007).
- Sauvie Island Bridge (Multnomah County) over the Columbia River – 365-foot steel tied arch span. Used SPMT to skid and load bridge on barges and floated span into place (2007).
- OR 47 over Dairy Creek Overflow Bridge, Washington County - Use of steel pile cap and reused salvage precast, prestressed slabs. Open to traffic in 14 days (2007).
- US 20 Bridge over Hayes Creek, Eddyville, Lincoln County - used of precast cap and slabs, constructed during a 72-hour road closure (2006).
- Lewis & Clark Deck Replacement (with WSDOT lead) 120 nights (9:30 pm-5:30 am closure) and 4 weekends. Use of SPMT to replace superstructure 5478' L X 34" W, 34 panels. WSDOT design 2004; conventional method - 4 years; or 6 month full closure (2004).
- Mill Creek Bridge Deck Replacement, OR26, Wasco County - 3-span continuous truss with deck panels replaced sequentially with partially concrete filled exodermic steel grid deck. 540-foot deck replaced in 24 days under flexible road closure schedule (2003).
- I-5 (Interstate) Bridge over the Columbia River, Portland – Accelerated the replacement of 2 trunnion assemblies and span/counterweight cables in the North End. $1.4+M incentive ($100K/day) was awarded the contractor for early completion in less than 7 days; 14 days ahead of the required 21-day schedule (1997).
- Imnaha Bridge over Little Sheep Creek – Single span, concrete-filled grid deck over steel curved girder bridge. Built first half of new bridge and switched traffic over; demolished existing bridge and built second half with some skidding to connect the two halves. Longitudinal concrete closure-pour in the middle (1997).
- Freemont Bridge over Willamette River, Portland. Arch span was floated on barges and moved into place using strands jacking (1973).
- Sam Jones Bridge - Full depth precast deck panels.
- OR 99E over Pudding River Bridge, Clackamas County – Erected new, longer and wider replacement steel truss adjacent to existing steel truss and skidded over (1940s).