MANAGEMENT

1) For the given federal NHS NHPP Funds under MAP 21, does your state predict the bridge conditions to degrade?
   17 Yes
   27 No
   If you answered "yes" to the above question, will your state targets be set to show degradation in condition?
   9 Yes
   7 No

2) Has your state established bridge deterioration models?
   21 Yes
   23 No
   If you answered "yes" to the above question, please describe:

   • Use Markov deterioration models
   • Deterioration models for all bridge elements were developed and implemented in XDOT’s Bridge Management System (BMS)
   • Network wide deterioration models for bridge health index and sufficiency.
   • Based on past history and bridge age.
   • PONT's based deterioration model.
   • Markov chain probabilities of NBI minimum condition ratings combined with projected funding and work types in order to predict future bridge condition and needs.
   • XX’s model is generated by PONTIS based on core element data. XDOT does not significantly use the model.
   • We utilize Piecewise linear models based on NBI component ratings.
   • They are rudimentary. We have established performance measures for 4 areas. General Appraisals, Deck Conditions, Wearing Surface Conditions, and Coating Conditions. We have established performances for each. We used our 20 plus years of data and did data mining on XDOT data. The models are XDOT specific and specific to our performance measures.
   • Deterioration models created based on actual deterioration, research posted on XDOT research website.
   • Pontis Core element deterioration models,
   • Based on Markov deterioration models.
   • An expert elicitation was used to determine deterioration rates. We have supplemented the elicitation with actual condition data over time.
   • Based on PONTIS deterioration predictions, ADT, detour lengths, roadway system and current bridge conditions
• Our current deterioration models will be no good with the requirement of using national Bridge Elements as per MAP 21.
• Simplified approach using NBI condition ratings.
• Developed but not yet fully integrated.

3) Does your state quantify RISK?
   15  Yes
   29  No

If you answered "yes" to the above question, please describe how your state quantifies RISK

• Not in a formal / established procedure
• Risk based approach for the management scour critical bridges that uses vulnerability and criticality to assign risk. It follows Guide to Highway Vulnerability Assessment for Critical Asset Identification and Protection, National Cooperative Highway Research Program Project 20-07/Task 151B.
• XDOT has developed a process that applies a classical risk assessment to our state bridge system, based on inventory and inspection data, and this process is used to program bridge projects. The outcome of this analysis is the determination of a Bridge Programming Index (BPI) for each state bridge as well as with a suggested work type and time frame for that work. BPI is a numerical value from 0-100 that represents a bridge’s relative priority for an investment in preservation, improvement or replacement work. Bridge element conditions, risk factors (such as scour susceptibility), and consequence factors (such as traffic volume and length of detour) are used to establish the probability and consequence of a bridge service interruption (such as a load restriction or traffic interruption due to repair work). Enhanced evaluation of the potential for interruption of service is provided by expert review of the data considered, including an in-depth examination of the most critical bridges to ensure the proper work type and timeframe are programmed. This review may result in a change in the ranking of a bridge based upon additional factors such as documented mitigation strategies that have been or will be implemented to manage an individual bridge. The last step of the process allows XDOT local bridge experts an opportunity to review the draft projects list suggested by this automated process to ensure bridge projects are programmed appropriately. The experts use their more intimate knowledge of the bridges and local transportation needs to adjust the project priority or to modify the scope or schedule of projects being planned.
• XDOT currently has a research project in Risk that should be finished in a couple of months.
• XX bridges with low condition ratings are placed on our “Red List” and inspected more frequently. We also have Scour Plans of Action and high-water reviews of scour susceptible bridges.
• Based on various factors: Condition, truck traffic volume, roadway classification, redundancy, clearances, etc.
• We has a methodology that evaluates risk based on ADT, Bridge Condition,
• Bridge replacement selection process includes risk items.
• Fracture critical structures, load posted structures, non-redundant pin and
  hanger assemblies and structures having general condition rating of 4 or less
  for deck, superstructure and substructure, are inspected every 12 months.
  System Classification, scour critical, fracture critical, etc.
• Using seismic and scour probabilities of occurrence.
• Factors used to quantify risk are: ADT, structure type, redundancy, simple or
  continuous design

4) What is the number of bridges in your state?
   State-owned    260256
   Local-owner    295121

5) What is the number of staff in your state’s Bridge Offices including design, construction
   and maintenance?  4959  (without California)

   Of the number above, please list the approximate percentage of staff involved in each
   specific activity (average):
   39%    involved in structure design
   13%    involved in structure construction
   20%    involved in inspections
   8%     involved in ratings
   20%    involved in other significant bridge activity;
   ☐ Fabrication inspection - 23 States
   ☐ Consultant plan review - 30 - States
   ☐ Bridge programming and management - 16 States
   ☐ Other:

   • Hydraulic and Administration
   • Repairs, Standards & Specs, Local Bridge project
     review/coordination, clerical, file and plan management.
   • Technical Resource
   • Hydraulic and Standards (IA-Methods, Preservation, and
     Permits
   • Research
   • Structural Research, Bridge Repair, Bridge Maintenance
   • Office management, office administration, hydraulics,
     consultant agreements, shop drawing review, IT, estimating.
   • Quantities
   • Policy Development, Data Entry, Electrical Technicians
   • Hydraulics
   • Administration
6) What is the percentage your state provides in-house design versus consulting out the bridge design? ________

- State-owned bridges
  - In-house Design __49__ (%)
  - Consulting Design __51__ (%)
- Local-owned bridges
  - In-house Design __14__ (%)
  - Consulting Design __86__ (%)

DESIGN

General

7) Has your state fully implemented the AASHTO LRFD Bridge Design Specifications?

- 39 Yes
- 7 No

If you answered “no” to the above question, please describe which aspects are problematic:

- Yes for bridges however, the only exception is specially designed retaining walls.
- Still have a few projects that are being designed under the old specifications
- Challenges with foundations.
- Cast-in-place retaining wall standards are being finalized in LRFD
- Use state-specific seismic design criteria
- Foundation design, retaining wall design

8) Which of the following does your state base bridge type selection on for conventional/ordinary bridges?

- Least initial cost - 25
- Life cycle analysis - 5
- Other - 20

If you answered “other” to the above question, please explain

- We use a combination of least initial cost and life cycle cost depending on the project.
- For typical bridges XX makes selections from four bridge types based on site conditions, highway alignment, initial cost, and maintenance experience.
Both costs are taken into account with other factors such as locations, visibility, construction, time and aesthetic, etc. Based on topography, foundation, drainage condition, highway limitations and environmental impact. Mostly, it is based on least initial cost. Sometimes site configuration, accessibility, construction duration and long term durability are additional factors which affect bridge type selection. Based on cost and the Department's preferences due to past performance of the structure types.

Appropriate for site needs combined with least initial cost

Based on Bridge selection Report.

Site specific constraints for requirements due to span type, length, environmental, RR, etc.

First, that the bridge fits the site constraints including environmental, ROW, historic, traffic control. Life cycle costs are considered but not through a formal analysis. Least costs are used as a tie breaker between feasible types.

No quantified life cycle analysis is completed. Bridge type selection is based on site constraints, aesthetics, and what is perceived to be lowest life cycle cost based on past experience.

Meet project goals (MOT, limitation of operations, etc.)

Combination of the least cost, environmental, constructability.

Combination of the two and considering future maintenance cost a factor.

Initial costs and future maintenance concerns.

In general Type Selection is based on least initial cost but there are several items and issues that are considered such as: Design, Environmental, Roadway, External, Permitting, Aesthetic, Construction, and Maintenance. A life cycle cost analysis is generally not conducted as part of our Type Selection.

Bridge type selection is based on best long term value using historic low bid costs

Least cost generally, but other considerations may trump least cost such as Environmental (open bottom structures), aesthetic, accelerated construction Decisions and maintenance of traffic.

Usually initial cost and life cycle cost get to the same answer.

Bridge type selection is determined through our Bridge Development Report (BDR) process, evaluating all aspects of the bridge (construction costs, loads, Maintenance, user costs Vs. ABC, etc.).

There are many factors including least initial cost, life cycle cost, site specific conditions, MOT costs, aesthetics, public involvement, inspect ability and more Bridge types are notconstruction time and schedule, environmental impacts selected merely by LIC or LCC.

Security
9) With the publication of the *Bridge Security Guidelines*, 1st Ed., what should the T1 Security Committee next focus on?

- To make sure that bridge plans well secured and to prevent accidentally give out without proper authorization
- The Committee should consider downsizing their activities.
- Extreme event response.
- Modifying the guidelines as they are applied in practice.
- Risk analysis for structures that are likely "targets" and mitigation tactics in case of failure for significant structures.
- More specific procedures for determining and accessing bridge importance as per Section 1.1.
- Recommendations for structures that should follow the guidelines – ADTT, importance, etc.
- Establish criteria for what bridge information should be made public.
- Theft of re-adjustable bridge components.
- Consider shutting down.
- Steel column bent should be part of the next research.
- Possible retrofit strengthening of existing bridges for security hardening.
- Training
- Possibly the effects of fire damage to bridges
- Recommend a common policy for public access to bridge information,
- Blast resistance of signature structures, cable stayed towers, etc.

**Seismic Design**

10) Does your state allow the use of seismic isolation bearings for ordinary bridges?

- 14 Yes
- 36 No

If you answered “yes” to the above question, please describe any limitations:

- Allow but have not designed any bridges other than seismic retrofit.
- Used only if needed to allow for the re-use of existing substructures.
- Considered "Unusual features" and requires QA reviews.
- We do not restrict isolation bearings. For our State, being in low seismic zone, isolation bearings are generally not required and/or not cost effective.
- Proprietary bearings must be on the pre-approved.
- Acceptable: Lead Core rubber, Pendulum, and sliding bearings
- We are working on policy to allow base isolation on Ord. Std. Bridges. Our biggest issue is to decide how much ductile capacity to require in the substructure.

**Concerns for long-term performance of seismically isolated bridges:**
• Bearing areas tend to collect a lot of dirt and water, so we have some concern with corrosion-related effects on sliding bearings.
• We do not have many seismically isolated bridges.
• Inspection, maintenance and repair guidelines need to be further refined.
• None have been in service long enough to be able to evaluate

11) Should the forced-based provisions specified in the *AASHTO LRFD Bridge Design Specifications* be?
   
   3- A—deleted
   17- B—replaced with the displacement-based provisions specified in the *AASHTO Guide Specifications for LRFD Seismic Bridge Design*.
   
   Please estimate number of years for transition: 5
   21- No change

12) Does your state use a moment-curvature or force-displacement analysis of reinforced/prestressed concrete members for load combinations other than seismic design?

   4 Yes
   37 No

   If you answered “yes” to the above question, please describe when these types of analysis have been used:

   • May be used to ensure ductility of non-seismic elements not satisfying code reinforcing limits.
   • XDOT uses moment curvature to obtain forces and displacements. This is used for continuous steel girders, prestressed girders, box culverts.
   • Only if one is stretching beam to limit or if bridge is a complex design
   • We have required moment curvature on all bridges with concrete substructures (except some slab bridges) since 1999.
   • Force-displacement (P-Δ) analysis is used for pier column design on typical bridges. Moment-curvature analysis is used for pier design on major bridges to determine partially cracked section properties.

**Loads**

13) Does your State routinely require the Strength II load combination in design of new bridges?

   11 Yes
   33 No

   If you answered “yes” to the above question, please provide:
Load factor $\gamma_{LL} = 1.35$

Axle weights and axle spacings (or insert Figure)

- Response #1
- Response #2—we use predecessor of Response #1
- Response #3
  Axle weight (16, 16, 28, 28, 28, 28, 28, 28) kips,
  Axle spacings (12, 4, 4, 4, 21, 4, 4, 4) ft
- Response #4
- Response #5
• Response #6
Axle weight (15, 20, 20, 20, 20, 20, 20, 20, 20) kips
Axle spacings (15, 4, 20, 4, 4, 4, 4, 4) ft.

• Response #7
9 axle: 2k(18')-24k(4.5')-24k(14')-24k(5')-24k(32')-24k(5')-24k(16')-
24k(4.5')-24k
13 axle: 18k(12')-20k(5.5')-20k(4.5')-20k(15')-20k(5')-20k(5')-
20k(43')-20k(5')-20k(16)-20k(16)-20k(5')-20k(5')-20k

• Response #8

• Response #9 The HL-93 truck only. This Limit State is used only to check
the beams under a sidewalk for a truck on the sidewalk.
- Response #10

![Diagram of CT-173.0 Legal Live Load Vehicle](image1)

*Note: CT-173.0 represents the construction vehicle described in Section 14-2600 of the CT General Statutes.*

![Diagram of CT-1352 Legal Live Load Vehicle](image2)

*Note: CT-1352 represents the vehicle described in Section 14-2602 of the CT General Statutes.*

![Diagram of CT-75.5 Permit Live Load Vehicle](image3)

*FIGURE 3.1*
Analysis

14) Refined live load analysis is called for when a structure is outside the ranges of applicability for approximate live load distribution. Which of the below apply to your state? Select all that apply

3 The range of applicability is ignored and approximate methods are used for all structures.
46 Our bridges are almost always within the range of applicability, or close enough to not warrant refined analysis.
2 We use alternative or different methods/formulas than specified in AASHTO for live load distribution.
14 Refined analysis of live loads is occasionally performed in-house.
10 Refined analysis of live loads is contracted out.
7 We would use refined methods of live load analysis more often if staff were appropriately trained.
10 We would use refined methods of live load analysis more often if the software were more user-friendly.

Other comments for T5:

- Is it possible to extend the range of applicability without revising equations?
- When span length L falls outside applicability range, we have conservatively used span length limit in AASHTO for LL distribution factor calculation. (example: for actual L = 260’, AASHTO limit =240’, so use L = 240’ for LLDF calculation)
- We have additional formulas for one and two-cell concrete box girders.
- Refined analysis is often used for bridge load rating. Longer spans should be looked at for AASHTO distribution factors.
- The range of applicability is ignored and approximate methods are used for all structures. Additional comments: the only issue we have had is Spread Box beams spaced closer than 6’. It is ignored and we use the distribution factor equations given in AASHTO 4.6.2.2.2.
- We only use refined analysis methods, if AASHTO LRFD Code requires it. Refined analysis is more time consuming, and additional conservatism capacity can be utilized during later stage of the bridge life by rating the bridge by refined analysis procedures.

15) Does your state have a policy differing from that of the AASHTO LRFD Bridge Design Specifications (Articles 4.6.2.2.2d and 4.6.2.2.3b) concerning exterior longitudinal beam design for prestressed concrete beams?
   9 Yes
   36 No

If you answered “yes” to the above question, please describe this policy:

- For decked bulb tee girders, Equations or “Lever Rule” not 4.6.2.2.2d.
- We do not design exterior girders separately from interior girders; however, we limit the deck overhang based on the beam type.
- State Bridge Design Manual 5.4.2.2.2:
- Distribution of live load to interior beams shall be as given in the AASHTO LRFD Specifications [AASHTO-LRFD 4.6.2.2], and the exterior beams shall have at least the same capacity. For skewed bridges the designer shall use the shear increase [AASHTO-LRFD 4.6.2.2.3c] but not the moment reduction [AASHTO-LRFD 4.6.2.2.2e].
For determining the live load shear and moment distribution factors for an exterior beam the designer shall follow the guidelines below.

1. For exterior beam design with the slab cantilever length (distance from the centerline of the exterior beam to the edge of the deck) equal to or less than one-half of the adjacent interior beam spacing, use the live load distribution factor for the interior beam.

2. For exterior beam design with slab cantilever length exceeding one-half of the adjacent interior beam spacing, use the lever rule with the multiple presence factor of 1.0 for single lane to determine the live load distribution. The live load used to design the exterior girder shall never be less than the live load used to design an interior girder.

3. The designer shall not use the analysis based on the conventional approximation of loads on piles [AASHTO-LRFD 4.6.2.2.2d].
   - Use of the “rigid cross-section” equation in C4.6.2.2.d-1 is not required
   - If an exterior beam needs a greater load capacity than an interior beam the designer shall check with the supervising Section Leader.
   - Require that exterior beams be of same strength as interior beams. Design them in accordance with Spec then select the controlling beam
   - When number of girders > 5. We don’t use Articles 4.6.2.2.2d and 4.6.2.2.3b.
   - Exterior beams must provide as much factored resistance as interior beams.
   - The same LLDF used for interior girders if the overhang is one-half or less of the adjacent girder space. Otherwise, the lever rule is applied.

Rationale/research/investigation led to this policy:

- Precast prestressed decked bulb girders behave in an articulated manner not rigid body rotation.
- Judgment and experience.
- When originally investigating the move from Std Specs to LRFD, it was noted that this could result in exterior beam governing the design. Based on past experience, discussions with other states and academia, and the small number of diaphragms used for prestressed beam bridges, it was decided to not require use of the rigid cross-section equation.
- Future widening.
- Economics
- An exterior beam has the potential to become an interior beam in a future widening project.
- If used, exterior beam controls the design. Prefer a more balanced design.
- Evaluation of the outcome of 4.6.2.2.2d and 4.6.2.2.3b for routine bridges led to this simplification.
16) Does your state have any technique to ensure that the exterior beam does not control the size of the prestressed concrete longitudinal bridge beams?

8 Yes
38 No

If you answered “yes” to the above question, please describe techniques used in your state to ensure the exterior beam does not control the design:

- Our policy is that typically exterior beams shall be the same section and capacity as the interior beams.
- Girder spacing adjustment. Distribution of DL for Barrier, Design when needed for widening as future interior girder.
- Minimize the overhangs and use either interior or exterior whichever governs when number of girders <=5 otherwise design for interior girder.
- Limit the deck overhang so the exterior beam does not govern.
- Apply a factor of 1.0 rather than 1.2 for multiple presences.
- Use shorter deck cantilevers to help balance design.
- Try to adjust the cantilever and beam spacing to balance the loading on the exterior and interior beams so that design is the same for both interior and exterior beams.

17) Does your state have a policy differing from that of the AASHTO LRFD Bridge Design Specifications (Articles 4.6.2.2.2d and 4.6.2.2.3b) concerning exterior longitudinal beam design for steel beams?

6 Yes
39 No

If you answered “yes” to the above question, please describe this policy:

- Pls note that this requirement seems overly conservative.
- Pls see #15
- State Bridge Design Manual 5.5.2.2.2: Distribution of live load to interior and exterior girders shall be as given in the AASHTO LRFD Specifications [AASHTO-LRFD 4.6.2.2]. For skewed bridges the designer shall use the shear increase [AASHTO-LRFD 4.6.2.2.3c] but not the moment reduction [AASHTO-LRFD 4.6.2.2.2e].
- Use of the “rigid cross-section” equation in C4.6.2.2.d-1 is not required, although we will require its use in the near future
- When number of girders > 5 .We don’t use Articles 4.6.2.2.2d and 4.6.2.2.3b
- Same as Concrete Girder

Rationale/research/investigation led to this policy:

- Conservatism in design for moment.
• When originally investigating the move from Std Specs to LRFD, it was noted that this could result in exterior beam governing the design. Based on past experience and discussions with other states and academia, it was decided to not require use of the rigid cross-section equation. However, we are reconsidering this based on discussions with BSDI’s Dann Hall & Mike Grubb.
• Economics
• Same as Concrete Beams

18) Does your state have any technique to ensure that the exterior beam does not control the size of the steel longitudinal bridge beams?

7  Yes
37  No

If you answered “yes” to the above question, please describe techniques used in your state to ensure the exterior beam does not control the design:

• See #16
• No technique, but Design Manual prohibits the exterior beam from having a lesser load carrying capacity. 407-1.01,
• For major Bridges. State Bridge Design Manual 5.5.2.1.1: Minimize the overhangs and use either interior or exterior whichever governs when number of girders <=5 otherwise design for interior girder. For economy and ease of fabrication, exterior and interior girders should use the same plate sizes. For future widening the exterior girder is required to have at least the same capacity as an interior girder [AASHTO-LRFD 2.5.2.7] and, for typical bridges, the office prefers that the exterior and interior girders be the same. However, for major bridges there may be significant savings if interior girders and exterior girders are optimized individually. If it appears that there would be significant savings with different interior and exterior girder designs the designer shall consult with the supervising Section Leader.
• XDOT limits the deck overhang so the exterior beam does not govern.
• Use shorter deck cantilevers to help balance design

Concrete

19) Does your state limit the tensile stress in prestressed concrete members to zero tension for the Service Load Combinations?

8  Yes
39  No

If you answered “yes” to above question,

Does this condition often govern the flexural design of the member (compared to the Strength Load Combinations)?

9  Yes
4  No
Does your state provide additional shear reinforcing steel to “balance” the moment and shear capacity at the Strength Limit State?

3 Yes
8 No

Comment: We limit the tensile stress in prestressed concrete members to zero tension for permanent load only. We allow tension under DL+LL service load combinations.

20) Does your state provide intermediate diaphragms for ALL precast prestressed I-girder bridges?

27 Yes
18 No

If you answered “no” to the above question, please list the cases where intermediate diaphragms are provided:

- If the bridge is 40 feet or less in length, we do not use a diaphragm.
- Spans 80-120’ @ midspan, Spans >120’ @ third points.
- Temporary diaphragms are required on all prestressed bridges
- Intermediate diaphragms are required for all beam sizes > 27” deep with spans > 45'-0". One diaphragm at midspan is required for spans between 45'-0" to 90'-0". Two evenly spaced intermediate diaphragms are required for spans greater than 90'-0".
- Spans > 40 ft
- Over 80 ft in general.
- Span over 50 ft.
- When span length > 150 ft.
- No intermediate diaphragms are required for spans up to 65 feet.
- Span Length greater than 40 ft

21) Does your state have standard details developed for intermediate diaphragms?

32 Yes
14 No

22) Does your state allow the use of full depth precast concrete decks for precast girder bridges?

28 Yes
16 No

If you answered “yes” to the above question, please list Limitations:

- We have never built or even been asked to approve this system, but we don’t preclude it.
- Used them only on 2 pilot projects and are still evaluating their use
- Special cased limited to ABC.
Skews, crowns and very wide bridges.
No limitations presently identified. We are constructing our first two projects now.
Cost, handling/transportation weight (costs) & seismic loads
Requires written approval of Department.
Generally overlayed with asphalt or PMC.
Evaluated for use on a case-by-case basis
Currently, the proposed full depth precast deck is for a deck replacement steel girder project.
Full depth precast concrete decks have been used only experimentally so far on accelerated bridge construction projects; the decks are not in widespread use.
Bridge deck cross slope.
Other than a research project, XDOT has not used them yet, however we are open to their use, which is subject to Bureau of Structures approval.
Decided case by case and approved by XDOT Bridge Group.
Currently performing some pilot projects.
No limitations have been developed yet.
XDOT has not used full depth precast concrete deck.
XDOT currently has not utilized full-depth deck panels; however we do have a test project currently under way. Some of the challenges include the following:
- Complexity and costs, inability to properly prepare the concrete surfaces prior to grouting build-ups, inability to ensure uniform bearing between beam lines, and
- ability to accommodate variable camber of prestressed beams.

If you answered “yes” to the above question, does your state have concerns for long-term performance of precast concrete decks?

9 Yes
15 No

23) Does your state allow the use of precast substructure for bridge members?

36 Yes
10 No

If you answered “yes” to the above question, please describe Limitations:

- Precast pile cap beams. See NCHRP 12-74 for basis.
- At the discretion of the Division of Bridges Director, would require unique provision to supplement the Standard Specifications for material acceptance.
- Element weight and connections, still in the learning process.
○ Routinely used to ABC.
○ ABC.
○ No limitations presently identified, except weight. Must be able to transport the Member to the job site.
○ Cost, handling/transportation weight (costs) & seismic loads.
○ Requires written approval of Department
○ One application for rehab of open spandrel arch. Arch had to be shored until installed precast spandrel columns as arch encasement sequence progressed.
○ Evaluated for use on a case-by-case basis
○ Case by case.
○ Precast substructure elements have been used only experimentally so far on accelerated bridge construction projects; the elements are not in widespread use,
○ Precast pile bent cap, piling.
○ XDOT has not used them a few times; their use is subject to Bureau of Structures approval.
○ Connection details, installation and joint performance
○ Criteria under development,
○ We have used them on a few pilot projects. Some things that have limited their use include lack of acceptance by contractors and difficulty in developing connection details that result in fast, efficient construction.
○ Constructability and less weight,
○ We are in the process of designing and constructing a few bridges. We intend to use UHPC for the longitudinal closure joints. For the transverse joints we may use standard grout with Post tensioning or UHPC and no PT. We have not arrived at a final decision on the best solution.
○ We don’t disapprove the use of precast substructure. However, it has not been used yet.
○ ABC, no limitation
○ Traffic control, ABC, and cost are main concerns for allowing the use of precast substructure.
○ Vertical post-tensioning strand cannot extend below elevation 12 feet below MHW.
○ ABC
○ Use prestressed concrete piles.
○ Require closure pours if the substructure element is divided into sections.

If you answered “yes” to the above question, does your state have concerns for long-term performance of precast substructure?

15 Yes
17 No
Steel

24) Does your state stop skewed frames at 20° or less per the *AASHTO LRFD Bridge Design Specifications* Articles 6.7.4.2 and C6.7.4.2?
   
   38 Yes
   7 No

25) Does your state use the approximate values for \( f_L \) (10.0 ksi for interior girders and 7.5 ksi for exterior girders) due to discontinuous cross frame per the *AASHTO LRFD Bridge Design Specifications* C6.10.1?
   
   27 Yes
   18 No

26) For long span, curved, and/or highly skewed steel bridges, does your state require contractors to use shoring towers/temporary supports for erection of girders?
   
   17 Yes
   26 No

27) For long span, curved, and/or highly skewed steel bridges, which of the following does your state develop camber diagrams based on:

   29 Instantaneous gravity (entire deck dead load placed simultaneously)
   16 Deck placement sequence

If you answered “deck placement sequence” does your state use a modified modular ratio for the deck concrete when developing steel girder camber diagrams?

   7 Yes
   9 No

   If you answered “yes” to above question, please provide \( n = _______ \)
   
   - 3\(E_s/E_c\)
   - Span less than 250 ft.
   - We have used both methods, depending on the geometric complexity of the bridge.
   - Use strength gain curve (see XDOT Structures Design Guidelines 4.2.8.B)

Decks

28) Which of the following does your state use to increase the long term performance of concrete decks? Select all that apply

   13 Low slump concrete overlay
   21 Latex modified concrete overlay
21 High performance concrete monolithic deck
25 Polymer overlays
11 Other

- High performance membrane with an HMA overlay,
- Membranes with Asphalt overlays.
- Barrier membrane with asphalt overlay.
- HPC,
- Micro Silica Concrete Overlay,
- Epoxy Coated Rebar.
- Asphalt & membrane.
- SFMC Overlay
- MMC overlay
- Microsilica, High-Reactivity Metakaolin
- (HRM) concrete overlay, Flyash or GGBF slag concrete overlay. Flyash or GGBF slag concrete overlay
- Silica Prime Concrete Overlay
- Epoxy coated reinforcement; additional clear cover
- Polyester polymer overlay
- Membrane waterproofing with bituminous concrete overlay
- Micro-silica
- Low slump, latxt modified high early strength, silica fume, calcuim sulfoaluminate (a.k.a. Low P), epoxy polymer, polyester polymer, and asphalt overlay. Note, tropically don't apply an overlay on new construction. After the deck shows some deterioration/distress, we apply them, on a properly prepared surface, as a preservation measure to extend the life of the deck

If your state uses low slump concrete overlays, which of the following has it applied on?

1  New bridge decks
5  Re-overlays
5  Both

Has your state noticed an increase in cracking in newly placed overlays?

11 Yes
15 No

If you answered “yes” to the above questions, has it resulted in a policy change in the use of low slump overlays?

☐ Yes
☐ No

Foundations
29) Has your state implemented LRFD for foundation (deep and shallow) designs?

  44 Yes
  2 No

If you answered “yes” to the above equation, please answer the following questions:

  What load factors are being used for lateral load?

  27 - AASHTO LRFD
  Several states - varies from 0.9 – 1.75

  What computer design software is being used for your LRFD foundation designs?

  10 Developed in-house
  o For Seismic Guide
  o Spreadsheets
  o MathCAD,
  o Spreadsheet, Mathcad
  o Excel, Mathcad
  o FG-Pier

  24 Commercial Software
  o FB-Pier
  o All Pile
  o RC Pier, L-Pile (drilled shafts)
  o L-Pile,
  o LEAP
  o Lpile, Driven
  o RC-Pier
  o L-Pile, Driven
  o SNSOFT, L-PILE
  o L-Pile Strain Wedge
  o ABUT LRFD by PENNDOT, NSOFT, PDI, Odana, GRL, Geostudio, Goldnail, ELE
  o L-Pile, RC-Pier
  o L-Pile, RePier, SAP2000
  o STAAD, Florida Pier.
  o RC-Pier
  o Lpile, All Pile.
  o L-Pile, Florida Pier, andABLRFD.
  o L-Pile
  o RCPIER, LPILE
  o SHAFT
  o FB Pier, SigmaW, GRLWEAP, Lpile, FOSSA, MSEW,
  o L-Pile, Group 8, STAAD, Driven, GRL WEAP
  o Com624
  o FB-Pier, FB-Multi Pier,
  o FB-Deep
o FHWA Driven, LPILE, Florida Pier
o V-Bent
o UniPile, Lpile, GRLWEAP
o RCPIER, L-PILE
o L-PILE
o FB-Pier
o FR-Multi Pier, Excel-FHWAGE010

Since implementation of LRFD, is there increased interaction between Geotechnical and Bridge Design engineers [regarding interpretation of Geotechnical Investigation data, and resistance factors to be used for geotechnical design calculations]?

37 Yes
5 No

If you answered “yes” to the above equation, have foundations become more economical since implementing LRFD?

5 Yes
18 No
14 Not sure

30) Does your state limit the location of resultant vertical footing forces to within B/6 from the center of the footing?

27 Yes. Use gross footing width
16 No. Use effective footing width

Please select applicable limit states:

22 Strength
14 Service
5 Extreme
13 All

31) Has your state used precast piles in integral abutments?

13 Yes
32 No

If you answered “yes” to above question, have there been issues requiring repair?

7 Yes
7 No

Abutments

32) Does your state allow bridge abutments supported directly on Mechanically Stabilized Earth Walls (MSEW)?

23 Yes
22 No
If you answered “yes” to the above question, please describe any limitations:

- Front edge of the footing must be at least 3 feet from the soil face of the wall.
- Cannot be integral abutment. Can be spread footing, stub pile supported or semi-integral.
- Limit bearing pressures to 4 ksf at service and 7 ksf at strength limit state.
- We’re using the GRS-IBS system (not MSE).
- Bearing, deflection, wall height, type of earth reinforcement (Chap 15, XDOT GDM).
- Only for single span structures where abutment settlement is not a concern and scour not an issue.
- Have used very rarely and only MSE walls reinforced with metallic reinforcement.
- FHWA Guidelines.
- Have only done this one time. May consider doing this with limited wall heights
- Ultimate bearing capacity < 4000 PSF.
- The MSE wall has to be designed for active seismic earth forces as well as the seismic forces from the superstructure. If the wall face is within 30 feet of a roadway, the panels need to be designed to the vehicular impact forces or acceptable barriers provided.
- Special compaction & panel joint geotextile requirements.
- (1) For Short or Stub Abutments, (2) Not desirable when MSES wall height exceeds 25-30 feet, (3) For shorter span bridges

If you answered “yes” to the above question, does your state have concerns for long-term performance of MSEW supported abutments?

9 Yes
9 No

**Barriers and Railings**

33) Has your state updated its bridge rail standards to meet the new *AASHTO Manual for Assessing Safety Hardware* (MASH) requirements?

20 Yes
25 No

34) Does your state allow use of adhesive anchors for attachment of metal rails?

19 Yes
26 No
35) Does your state allow use of adhesive anchors for attachment of concrete barriers to bridge decks?
   24 Yes
   22 No
   If you answered “yes” to either of the two questions above, do you require installer certification?
   9 Yes
   15 No

Sign/Light Structures

36) Does your state provide design engineers with clear guidance (e.g., procedures and/or design examples) that specifically pertains to typical anchor-bolt-group-to-concrete-foundation connections for sign trusses and/or high-mast light towers?
   18 Yes
   28 No
   If you answered “yes” to the above question, please list the codes or research reports on which your procedures/examples are based:
   - Mast Arm Program, Overhead Sign Program Research: BDK-977-32, BA585, B8804, BL354-04,
   - Connections are provided in Standard Drawings,
   - FHWA NHI 05-36, Guidelines for the installation inspection, maintenance, and repair of structural support for Highway signs, luminaries and traffic signals.
   - Based upon years of inspection and research related to failures.
   - We follow the 2009 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals Section 5.17.4.1 Distribution of Anchor Bolt Forces
   - Accordance with the AASHTO Specifications.
   - Standard designs are used, with the exception of high mast luminaries.
   - Standard details that are designed per AASHTO
   - AASHTO Standard Spec for Structural Support, and XDOT’s Standard Specifications
   - No specific codes are referenced. Design requirements reflect Department practices.
   - Base sheets are provided as a basis for details, but computational examples are not provided.
   - We provide standard designs that cover 90% of all structures

37) Has your state had any in-service failures of high-mast lighting towers or posts for sign/signal support structures that can be attributed to the presence of welded-rim hand holes that the width of reinforced holes and cutouts in the cross-sectional plane of the tube is less than 40 percent of the tube diameter at that section?
3 Yes
43 No
If you answered “yes” to the above question, please provide
Number of total failures: ______3_________
Number of failures - high-mast lighting towers: _____2________
Number of failures - sign/signal support structures: ___1________

38) Does your state provide clear guidance to design engineers for the need for reinforcement and for type of reinforcement for holes in tubes in sign, lighting, or signal structures?
   21 Yes
   25 No

39) Are you aware of research on any of the following topics regarding sign, lighting or signal structures?
   • Axial, bending, shear, or torsional strength of tubes with holes? 2 Yes  42 No
   • Axial, bending, shear, or torsional strength of tubes with seam welds? 0 Yes  46 No
   • Crashworthiness of tubes with holes? 0 Yes  46 No
   • Fastener-attached (rather than welded) hole reinforcement in tubes? 0 Yes  46 No
     Multiple holes in tubes in close proximity? 0 Yes  46 No
   • Holes close to a hard point in a tube such as a transverse or longitudinal attachment? 0 Yes  46 No

If you answered “yes” to any of the items, please cite the research sources.
   o Valmont performed some full scale destructive tests approx 10 years ago on XDOT’s spec lighting poles with reinforced handholes. It was in the context of acceptance testing done in lieu of transverse crush test. It was not research project, so there was no overall report that I know of and there were probably no control specimens (such as specimens without holes). At XDOT we don’t seem to have much info handy anymore on the individual test results. However, in some case the failure mode involved buckling at or next to reinforced handholes.
   o Consulting NCHRP 469.
   o XDOT hired a consultant to create a report about the effect of an elongated handhole with torsion.

CONSTRUCTION

40) Does your state allow narrow gap electroslag welding of tension butt splices per the 2010 AWS D1.5?
   26 Yes
   18 No

41) How long does your state wet cure newly poured bridge decks?
9 - 5 days
22 - 7 days
8 - 14 days
7 - Other
  o (4 States) - 10 days
  o (1 State) - 4 days for normal concrete and 7 days for HPC
  o (1 State) 7-10 Days.
  o (1 State) 7 days for standard concrete; 14 days for high performance concrete.

42) Does your state allow curing compound on your bridge decks?
   30 Yes
   15 No
   If you answered “yes” to the above question, please specify time of usage:
   15 Before the wet cure time
   2 During the wet cure time
   6 After the wet cure time

43) Does your state seal gaps in split median barriers of parallel bridges?
   15 Yes
   31 No
   If you answered “yes” to the above question, does your state employ a hard seal such as a neoprene membrane?
   7 Yes
   7 No

44) Has your state employed preservatives such as silane or methyl methacrylate on new bridge decks?
   28 Yes
   16 No
   If you answered “yes” to the above question, please describe types and conditions:
   o To seal cracks
   o Silanes on bridge decks and railing
   o Used silane on concrete wearing surfaces, sidewalks, curbs and fascias.
   o Apply a silane seal on new deck.
   o Silane required on all new decks.
   o Silane along face of curb, top and face of coping and underside of coping to edge of exterior girder flange.
   o Silane on all new decks, methyl methacrylate to treat some decks with cracks.
   o Methyl methacrylate on cracks in new decks.
   o Silane (40% minimum silane) on state bridges.
   o Cracking
Mitigation for cracking.
Is used for HPC decks containing 30% fly ash. Also, for instances of cracking in new decks, contractor can choose methyl methacrylate or epoxy to seal cracks.
Silane for all new deck cracks, Low disenty healer-sealer for cracked deck.
2-component polymer resin binder with aggregate where traffic volumes are high, to reduce future maintenance, where stainless rebar is not justified.
When we fail to get the desired cover over the rebar
Use with stay-in-place form, AC overlay, special climate

45) Does your state use a high early strength concrete specification for rapid reconstruction of expansion joints?
28 Yes
17 No

MAINTENANCE

Rehabilitation

46) For locally-owned bridges maintained by your state, please provide the following:
   Number of bridges in 1 yr: Replacements 414 Rehabilitations 154
   Construction Cost ($): Replacements _____ Rehabilitations ______

Inspection

47) Does your state have a policy requiring Bridge inspectors to be a registered Engineer?
7 Yes
37 No

48) Is your state satisfied with current PONTIS?
11 Yes
32 No

49) Is your state clear on the direction of future PONTIS version?
19 Yes
25 No

50) Should the current 24 month inspection cycle be revised (increased) for bridges that are in good condition, relatively young age, durable construction, redundant load paths, etc.?
32 Yes
10 No
51) Should the substitution of side-scan sonar be allowed for alternating five-year underwater inspection cycles for bridges where scour is the primary threat?

   20 Yes
   18 No

52) Does your state inspect earth retaining walls?

   11 Yes
   19 No
   15 Sometimes

   If you answered “yes” to the above question, please provide
   Wall types:
   - (2 States) - All if close to a bridge
   - All over 6 ft tall
   - (2 States) All
   - MSE
   - Concrete and MSE walls
   - MSE, Post and Plank, Reinforced Concrete
   - MSE, cast-in-place
   - Concrete, Timber, Metal, etc

   Inspection cycle (Year):
   - 254 month w/bridge,
   - 4 years
   - (2 States) 2 Years
   - (2 States) - same as bridge cycle
   - 5 Year

   Gathered information:
   - Deformations and surface appearance.
   - Cores
   - Typical NBIS Inspection Data
   - General information condition
   - Condition, settlement
   - Condition, Fill Loss, Settlement.
   - Field data collected: wall condition, drainage issues, backfill issues and barrier. For the inventory we gather key information from the design plans, wall height, length, foundation type, backfill material, etc

Load Rating and Posting

53) Does your state have minimum load rating requirements (HS__ for LFR or RF =__ for LRFR) for existing bridges for preservation and improvement projects?

   26 Yes
   19 No

   If you answered “yes” to the above question, please describe
The minimum rating requirements for design loads:

- HS, HL93 and 3 Legals.
- Existing bridges are typically required to rate HS20 or greater at the inventory level after the project.
- 3-ton min.
- HL-93 and XDOT special design load that modifies HL-93 magnification factor.
- Established minimum rating factors for bridge rehabilitation projects depending on the roadway classification.
- HS18.
- Carry XX Legal Loads; Prefer HS25 and 1.25 Mil or HL93 (HS15.4 to HS32 depending on how many axles the span sees.)
- HS 20 Inventory Rating.
- Permit trucks using Strength 4 as described in Br Design Manual.
- H-15 at Operating Level (LFR), N/A for LRFR.
- Must be at least HS20 for consideration.
- First an LRFR check is made, and if all rating factors are 1.0 and at the operating level a 1.67 rating is achieved for an HS20 vehicle then it is ok, if this fails an LFR is checked to see if 60 tons operating rating for the HS vehicle. The next step is to perform finite element analysis, if not a variance must be approved, or the bridge is replaced.
- A minimum HS-10 rating is required for overlay projects (after the overlay is in place). A minimum HS-18 rating is required for any rehab project on a bridge carrying the Interstate.
- RF = 0.8  HS20  28 tons   LFR
- HL-93 Inventory level – Rating factor - no minimum value;
- HL-93 Operating level – Rating factor 1.0 unless specifically permitted.
- Ratings based on design loads specified in original design drawings. For older bridges, it is usually HS20 @ Inventory level (20T). For bridges using LFD/ASD HS-20 at Inventory RF>1.0 (36T) and Bridges using LRFD Rating is per LRFR (RF>1) and HS-20 and HL-93 vehicle is used. Currently Design Manual including Loading/Posting are under revision.
- Improvement - HS 25 for LFD and RF=1.0 for LRFD Preservation (Repair) - Do not have minimum
- For state owned, no load posting.
- HS=20.
- We do not perform LRFR ratings for preservation projects. For preservation projects we require the LFR Operating Rating Factor to be greater than 1.0
- For improvements, we perform a LRFR rating to be greater than 1.0

The minimum rating requirements for overweight permit loads:

- XDOT has 5 Permit vehicles. A 5-axle is the smallest and a 13-axle is the largest.
o A study has shown an inventory rating of HS20 also envelopes our routine permit loads. Single trip permits are analyzed individually.

o Any load exceeding 80,000 lbs is classified as a permit load. Should rate RF>1 for HS-20-44 & capacity = 36 T (Inventory) & 45 T (Operating).

o Steel - Yield Stress, Concrete-Ultimate.

o HS20

o Rating Factor – 1.0,

o For Military Heavy Equipment Transport - RF=1.0. (LA) - Own special P-load,

o HS 33 Operating Rating.

o Single-trip permits are analyzed specifically based on vehicle and route. Multi-trip permits are regulated based on the analysis of the XX Standard Permit Vehicle (XX-SPV). This vehicle was designed to envelope the effects of multi-trip permit vehicles.

o RF > 1.0 for XX Legal Loads. Exceptions may include historical bridges or bridges originally designed for lighter loads and it has been decided not to upgrade the bridge.

o If the above is achieved then 1.0 rating factors should be achieved for the routine permits.

o Checked for each permit.

o Load effect of overweight permit vehicle should be less than the HS Operating Rating of the bridge.

54) Does your state use the permitting procedures specified in AASHTO MBE

22 Yes
24 No

If answered “yes” to the above question, please specify the factor used:

12 Factors specified in MBE
3 State-specified factors

55) For bridge posting, what percentage of Operating Rating is specified for a bridge weight restriction?

20 - 100%

o Bridges are posted at Inventory Rating,

o At present bridges are posted if they rate < 16T for HS20 vehicle (inventory) (0.8 x Inventory Capacity 20T (H20)). Operating ratings used for permitting.

o We use the safe load capacity = H- Operating(tons) x K, where K is a factor that depends on the type and condition of the structure, and can vary from 0.6 to 1.0.

o Less than 100% of XX Legal Loads

o Based on bridge posting on the Inventory Rating.
Load posting is not based on percentage of operating rating. We rate for state posting vehicles to determine posting capacity.

- Applies MBE Eqn. 6A.8.3-1 to the LFR - calculated operating rating factor to determine a final bridge weight restriction. This equation results in varying percentages, dependent on rating vehicle weight & operating rating factor value.
- 100% for State Owned, 80% ± for Locally Owned (Avg of Opg & Inv).
- For steel bridge, mid range of OR and IN. For concrete bridge, at OR.
- We currently use inventory rating but considering change. Have not decided percentage of operating rating when we do change.
- RF for LRFR. Post at 0.67Fy; State Posting Limit.
- Bridges are posted for legal vehicles, the higher blanket permit vehicle (90k) RF < 1.0 and at legal vehicle operation or below if the legal vehicle RF < 1.0. For LFR, the safe posting of legal load shall be the following: Steel or timber structures - the capacity at a load level midway between inventory and operating. Concrete superstructures - the capacity at the operating level.
- Posting in XX is not based on the Operating Rating – we analyze using AASHTO Legal trucks to post. A percentage can correlate to 23 min allowed/32.4 tons = 70.99%
- We use LRFR. It goes by Safe Load Posting. We post for XDOT Legal Loads.
- 100% Operating Rating for State System Bridges, 100% Inventory System for Off System Bridges.
- 100% for bridges with ADT below 10,000 and low ADTT. 75% for bridges with ADT above 10,000 with high ADTT, or with
- Superstructure condition ratings of 4 or less.
- No specific percentage used, restriction is set between operating and inventory, taking into consideration the structure type and structure history.
- Load effect of overweight permit vehicle should be less than the HS Operating Rating of the bridge.

Bridge Preservation

56) T-9 is working to develop guidelines for the following five issues. Please rank those five or other issues would you most like to see T-9 complete with 1 being the highest priority?

- Service Life design ______2______
- Bridge preservation decision (for scheduling preservation actions such as cleaning, spot painting, joint repair, sealing, deck overlays, etc.) ______1______
- Life extension of steel paint ______4______
- Bridge preservation budget ______3______
• Voids and corrosion investigation in PT ducts 5
• Other:
  □ Methods for deck preservation
  □ Deck Expansion Joint
  □ Deck concrete chloride contents VERSUS corrosion in steel rebar

57) What percent of your state bridge program budget is spent on bridge preservation (not counting routine maintenance)?

25 (%)__

24 My state used the definition of preservation in the FHWA Bridge Preservation guide.
13 My state used our definition of bridge preservation
My state used another definition of bridge preservation ________

58) What is your highest priority bridge preservation research need with 1 being the highest priority?
• Deck overlay life expectancy 2
• Deck corrosion mitigation 1
• Superstructure corrosion 3
• Superstructure cracking 4
• Substructure stability/scour 5
• Substructure corrosion 6
• Other:
  o Deck cracking
  o ASR mitigation in the absence of fly ash
  o Deck Expansion Joint
  o New steel and concrete coatings; deck joint performance.