THE CONSTRUCTABILITY REVIEW PROCESS
IN A SMALL STATE HIGHWAY AGENCY: A CASE STUDY

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Often, after Departments of Transportation (DOTs) complete the National Environmental Policy Act (NEPA) process and procure all environmental permits on their projects, contractors or design-builders might submit ideas to improve project design. Many of these ideas would improve major aspects of the project (time, cost, quality); but, often, their implementation would change some aspect of project design that would trigger a NEPA re-evaluation or a replication of the environmental-permitting process. DOTs often hesitate or even refuse to consider these ideas, no matter how good, because they fear costly and time-consuming reassessments that would delay the project. To benefit from innovative proposed design changes on their projects, the transportation industry needs a Constructability Review Process (CRP) that will at once meet all constructability requirements and not clash with the NEPA and environmental permitting processes. This paper presents a case study investigating the current CRP implemented by the Connecticut DOT, with special focus on how the agency coordinates its CRP with the NEPA and environmental permitting processes.

Keywords: Buildability, NEPA, Environmental permitting, Highway design, Project management.

1 INTRODUCTION

The term “constructability” was introduced into the U.S. transportation construction industry in the late 1980s to measure how easily and efficiently a structure could be built with the construction documents provided for it. The early 1990s saw a flurry of important research on this topic. Constructability Reviews (CRs) were the most important practical outcome of this research, and departments of transportation (DOTs) quickly began developing and implementing constructability review processes (CRPs). By the mid-1990s, this new practice was being used by most of the 52 DOTs in the U.S., and the transportation construction industry seemed to have largely solved the problem posed by inadequate designs/plans (Hugo et al. 1990, Gugel and Russell 1994, Russell and Severson 1992, Radtke and Russell 1993) (Russell and Gugel 1993). After about a decade, two significant changes to the transportation construction process caused the problem of constructability to re-emerge. First, the number and intensity of environmental regulations and permitting requirements increased exponentially. This new challenge was then exacerbated by the proliferation of integrated project delivery methods, all of which encourage design input from the contractor and increase the speed of the project execution process. The major benefits of CRs from past research
include reduced project delays, claims, disputes, errors in the contract documents, and cost escalations (Minchin et al. 2022).

This case study intends to document the details of the CRP employed by the Connecticut Department of Transportation (ConnDOT). The processes and anecdotes documented here were drawn from interviews with agency personnel from highway and bridge construction projects. The ConnDOT employees interviewed include district and Central Office staff representing the Planning, Construction, Design, and Environmental sections of the department. Construction contractors in Connecticut were also interviewed. The research was sponsored by the National Cooperative Highway Research Program (Minchin et al. 2022).

2 CONSTRUCTABILITY REVIEW PROGRAM

All ConnDOT projects receive a constructability review (CR), and the districts often assemble special teams to execute CRs on their projects. A project’s constructability review process (CRP) is informally set into motion when the staff first assembles to establish the project’s details and scope—for instance, whether it will be a new facility or a rehab. After these determinations are made, the CRP progresses through a pre-survey scoping meeting; and, once the scope is set, the project is placed on the monthly Interagency Meeting agenda.

These meetings allow the regulators to communicate what they expect to be included in the design of ConnDOT projects. These meetings occur well in advance of the thirty-percent plans review. Once the designers know enough details of the structure being planned, they produce a 2-D sketch to introduce the project to the regulatory agencies attending the monthly meetings.

Since it is never too early to identify design problems, any changes requested at an Interagency Meeting are relayed to the project designers, who incorporate them into the 2-D project sketch. The Design Office then sends the revised sketch to the Construction Office. The next step in the CRP is a thirty-percent Plans Review. As part of this review, all units receive thirty-percent plans and conceptual specifications. This review is also known as the “Blue Beam Review” after the software through which the plans are distributed. All groups then use a Plans Review Checklist to review the plans and make comments.

The CRP next proceeds to the sixty-percent plans review, or the “Plans Review and Structural Layout.” Even though, by this point, the Central Office has been conducting a CRP for some time, the prevailing opinion among district personnel is that the CRP only just then commences. The in-house people that had executed the Blue Beam Review re-assemble for this exercise. Occasionally, at about this point in the process, contractors are contacted, and queried in a nonspecific structure, informally, on their ideas on constructability issues. The same format and software are used as with the Blue Beam Review. On projects with particular traffic concerns, the Design, Traffic, and Construction units also convene at about this time to discuss these matters.

The Design section performs a Plans-in-Hand Review at some point between the sixty- and ninety-percent plans stages on all Design-Bid-Build projects. Sometimes, a field walk is included in this Plans-in-Hand Review. Major problems have been identified at this meeting, but the department says, “We just don’t have enough quality, experienced people to [perform proper CRs].” To help address this shortcoming, the State Design Office has retained a consultant on a task-based, on-call basis. The consulting firm often performs its own CR.

At this point in the CRP, the reviewers usually gather in a room with two big screens. Screen No. 1 shows the location of the project on Google Earth; Screen No. 2 presents the plans. Superimposing the plans over Google Earth helps presenters explain the project to the public. After this presentation, the Design unit is no longer involved in matters related to constructability. Once the public has been properly notified, ConnDOT prepares for project letting by holding a formal online Q&A session.

ConnDOT’s CRP includes a semi-annual meeting at which the Manager of the Construction Operations division presides over a Lessons Learned Summit. Construction
personnel from every district attend, including all District Construction Engineers. An equal number of Design personnel from every district also attend, including all District Design Engineers.

The final step in ConnDOT’s CRP is the completion of a CR form, to capture problems and solutions from the project. The Construction Project Manager is expected to complete this form at the conclusion of every project.

ConnDOT conducts a formal review after each project, measuring the effectiveness of its CRP. This review largely consists of the Central Office tracking cost and time overruns. The districts have come to compete to see which of them can achieve the lowest overrun percentages. The department claims never to have had success with the participation of active contractors in a CR until the “Walk” Project, a currently ongoing bridge replacement project in Norwalk. Traditionally, “[the contractors] have just used their presence as a way to reconnoiter the project and go mum; and [they] won’t tell you what they think. It is a waste of time. Retired contractors are the way to go.”

A CR is NOT a Plans Review, and dozens of issues can be discussed and resolved without contract documents (including plans), as long as the right people are in the room. A notable example of the power of such a CR was the Stevenson Dam project, on Route 34, over the Housatonic River. Here, while the reviewers had a set of plans to relocate a bridge, they were obsolete, since they were for a bridge in a location that had fallen out of favor with planners. Still, as the following case study of this project shows, they were able to perform a very effective CR by paying attention to major construction issues. This project case study within this larger program case study powerfully and patiently makes the case for commencing the CRP during the Planning stage. The consensus of the entire research team was that the earlier one can commence the CRP, the better; moreover, the team further agreed that the earlier one can involve the contractor in the design process, the smoother the process and the better the project quality.

2.1 Case Study Within the Case Study: The Stevenson Dam Bridge Project

In 1919, a bridge riding astride the Stevenson Dam was constructed to connect Monroe and Oxford, Connecticut. Forming an important portion of State Road 34, the bridge overlooks Lake Zoar, the lake produced by the dam—a source of hydroelectric power that blocks and strategically releases the flow of the Housatonic River. In 1959, the north end of the bridge was lengthened by two spans when flood control tainter gates were added to the dam to increase spillway capacity. Twenty years after that, the deck structure was widened and rehabilitated. Because of its consistently low service and safety ratings, the bridge had become obsolete by the end of the 20th century, and its obsolescence created a controversy that was about to enter its fourth decade when it was finally resolved in 2019 (Connecticut DOT 2019). The bridge’s level of service was rated as “Poor” in the 1990s, and crash analysis data pointed to the bridge as one of the least safe stretches of roadway in the state. The angles of curvature needed to keep the bridge perched atop the crescent-shaped dam made it almost impossible for a tractor-trailer unit to stay in its lane at speeds of even 20 miles per hour. As the dam and bridge aged, structural concerns became manifest. A 1995 inspection identified the following problems: heavy rusting of steel beams; open cracks and hollow areas in concrete cantilevers supporting the deck; cracks and spalls in the deck slab; deteriorated expansion joints; frozen steel bearings; open cracks in concrete T-beams; and cracking and spalling in the substructure elements (Conn DOT 2019). At that time, the bridge was estimated to have a future useful life expectancy of three to five years. The seven principle areas of need were identified as Bridge structural condition, Road/bridge geometry (curves), Road/bridge width: lanes/shoulders/sidewalks, Sight distance, Bike/pedestrian/recreational user safety and accommodation, Hydroelectric facility accommodation and safe access, and Maintenance and Inspection crew safety (Conn DOT 2019).
In 1998, a comprehensive Environmental Assessment (EA) produced a list of 10 alternatives, including the options of doing nothing and of rehabilitating the existing bridge. The other eight alternatives involved a new bridge either upstream or downstream of the dam. After spirited debate, an alternative was chosen to build a bridge upstream from the dam, crossing the lake closer to the dam than any other alternative. This alternative would have the least impact on recreation, specifically, the town boat ramp, and on the visual environment. Another point in its favor was that it would have the least impact on the bald-eagle habitat downstream. Of concern was the fact that this location and the design it would likely necessitate would not meet all design standards (Conn DOT 2019).

The department chose a VE study as the best option for re-addressing this problem, since the current ConnDOT CRP does not begin in the planning stages. However, the process was considered to function as a CR because many construction personnel were invited, and the function was that of a CR. A CR was needed in this case during the planning stage, and one was essentially performed within the ambit of a VE study. The Environmental Director went on to emphasize that a CR is possible before any plans are created. She stated, “one does not need plans to perform a Constructability Review—a Constructability Review is not a Plans Review” (though a Plans Review can certainly be part of a CR). She is firm in her belief that, many times, the CRP should commence before any plans are developed—at or before the beginning of the NEPA process. While no pertinent plans had been developed in this case, the right people met and resolved a decades-long quandary by considering constructability (based on interview and email correspondence with Kimberly Lesay in 2019). The two main lessons learned from this quasi-CRP were 1) plans are not needed to execute a CRP, and 2) the earlier in the process that one commences the CRP, the better.

2.2 NEPA / Environmental Permitting

None of the ConnDOT interviewees could remember ever rejecting a design change request/idea solely because its approval would mean a NEPA Re-evaluation or a re-do of an environmental-permitting process; but neither did any of them deny such a situation has, or could, happen.

An innovation the State Environmental Office is pushing is called the Pre-NEPA Study. The thinking is that ConnDOT enters the NEPA process with too many alternatives, and that this superfluity leads to confusion and delay. Many of the alternatives are unreasonable, and the department should eliminate them before approaching NEPA regulators. One interviewee explained that, as the process now stands, there are “just too many [alternatives] for us to cover properly,” adding that some of these alternatives are unenforceable or unaffordable. Why, for instance, he asked, list a tunnel as an alternative when it will probably never pass NEPA, and “we can’t afford it anyway?” The process would be substantially streamlined were only reasonable, affordable options sent to NEPA. This could be accomplished through a Pre-NEPA Study that implicitly considers the constructability of all options. This is where the CRP should begin!

The department has resolved to become more sophisticated in its approach to NEPA—especially in terms of the media/tools it already uses. The department has used video clips of drivers’ experience on existing roadways/facilities to great effect in the past. Also, 3-D renderings of proposed facilities have proven to be an effective tool for many departmental purposes. The question was asked, “Why can’t we use these tools in our CRP?”

The “Mixmaster project” is using another major change the department has recently piloted. For this project, the department retained a consultant as Project Manager, but not just to handle NEPA/permitting, as was the traditional practice. Instead, this consultant took everything into account, not only environmental issues. The interviewees expressed hope that this approach will be the way of the future at ConnDOT, as this is another way to get all the right people in the room early in the process.
2.2.1 New technology and methods

Designers of the “Q-Bridge” project over the Quinnipiac River, near New Haven very effectively used 3- and 4-D modeling, a process that, while very expensive, accurately identified potential construction/design conflicts. The expense makes the practice unlikely to be widely used, except on the most highly visible and complex projects. The process is currently being implemented on one large bridge project.

ConnDOT is using the CM/GC delivery system to build the “Walk” Bridge, a large train trestle project in Norwalk. The department does not need to execute a formal CRP on this project, since this process is built into a CM/GC project. They are, however, using an effective CRP tool, the ABC Decision Matrix, to choose between similar design options for this project. Since the project is a case of superstructure replacement, it required a temporary bridge widening costing millions of dollars. The ABC Decision Matrix recommended the closure of all lanes but one on Interstate-95 for 30 hours, spread out over four closings. The idea seemed impossible and risky, and the department proceeded with due caution; but when implemented, the plan worked well and saved millions of dollars.

3 CONCLUSIONS AND MAIN TAKEAWAYS

- The ConnDOT CRP informally begins when personnel first meet to determine the details and scope of the project—such as whether a job will be a new facility or a rehab.
- It is never too early to identify problems in the design. Among the scores of advantages of starting early is that starting the CRP early can prevent “scope creep.”
- By the time the Construction unit sees the project, the NEPA process is complete, the permits hopefully are procured, and the public has been advised.
- ConnDOT formally begins their CRP when the Design Office sends a 2-D sketch to the Construction Office, after making changes regulators have requested at the Interagency Meeting.
- One step in the department’s CRP happens in conjunction with the 30-percent Plans Review. Units also receive conceptual specifications and submit comments through the Blue Beam software platform.
- Connecticut contractors expressed dissatisfaction with the ConnDOT CRP.
- The CRP does not end at award. As soon as the public has seen the plans and the project moves forward from there, any CRP activity is facilitated by the Construction unit.
- The last step in the CRP on every project is a post-project CR form to capture lessons learned for future projects.
- The Central office tracks the percent cost overruns and the percent time overruns on projects. Competition is generated between the districts based on these percentages.
- ConnDOT claims never to have had success including active contractors in a CR until the current “Walk” Project. Agency interviewees reported that, traditionally, these contractors have just used their CR participation to reconnoiter the project without offering any useful input.
- Recent lessons learned have reinforced the concept that a CR does not require a set of plans. A CR is NOT a Plans Review.
- The State Environmental Office is pushing an innovation called the Pre-NEPA Study that assumes that ConnDOT goes into NEPA with too many design alternatives, which leads to confusion and process delay. Because so many of the alternatives are unreasonable, they should be eliminated. The CRP should begin at this point in project development (i.e., preparing for the NEPA process).
• ConnDOT used 3- and 4-D modeling to great effect on the “Q-Bridge” project over the Quinnipiac River near New Haven, although the process proved to be expensive (Minchin et al. 2022)

4 REFERENCES

ConnDOT, Improvement/Replacement of the Stevenson Dam Bridge: Carrying Route 34 over the Housatonic River, 2019.


