Table of Contents

Chapter 1-Title Sheet

The Title Sheet can be thought of as the summary sheet for the entire project. You'll find the project name, project number, county, location map, designer, project engineer, a sheet index, revision table, scale, and many other useful pieces of information. A quick glance at your example plans would show almost immediately that this bridge is to be built in Gilmer County on county route 22, a state and local service route. It's in the Troy Magisterial District, 3 miles West of Tanner. It was designed by Alex T. Quesinberry and checked by Rob. Chad is the responsible charge engineer, which means he signs off on the whole set as true and correct to the best of his ability with his professional stamp of approval.

Before we go too much further, we need to discuss a few pieces of terminology. We use the word "centerline" a lot, so it's important to listen to what words come after it. Centerline of roadway, centerline of pile, centerline of bearing, and centerline of abutment, and centerline of bridge are all different things. As such, it's easy to confuse them because sometimes they're even the same thing. For example, centerline of roadway, centerline of abutment, and centerline of bridge can all be the same line. Frequently they are, but be aware that they can sometimes be separate.

When discussing centerline of roadway, we find it necessary to come up with some way to enumerate it. That is, break it down into sections so we can orient ourselves. That's why we use stationing. Simply put, stationing, or stations, represent the roadway in 25-foot pieces. We usually start at zero, or 0+00.00. The next station would be 0+25.00, or 25 feet ahead (forward) station, and every 25 feet afterward. The only time we deviate from the 25-foot breaks are at important stations, such as the beginning of a bridge or the intersection of another road. Every road in our system has a direction, so we also try to line the stationing up with that direction. Although we're not always successful, this makes it much easier for future plan makers and builders to use our plans as reference.

Another piece of information on the Title Sheet that may not seem important is the A.D.T. in the lower left corner. So, what's a home security system have to do with a bridge you ask? Nothing… A.D.T. is an abbreviation for "Average Daily Traffic." As you might imagine, this number represents the number of vehicles per day that use the structure. Sometimes it's based on traffic count, sometimes it's based on an educated guess, but it determines many things before the project even gets to the plan stage. It's used to classify what type of roadway the structure is on, it's importance in comparison to other routes, and requirements we need to meet when replacing it. You can also logically assume that traffic will increase in the future. To cope with that, we also use a future A.D.T., which is what our design is actually based on. As far as you guys are concerned, it's a great indicator of what kind of traffic issues you'll have to deal with.

Just under the project site map in the upper left-hand corner of the Title Sheet, you'll also see a "Utilities" section. We hope for most projects it's blank. For our example, it is not. This is where we list the utilities we'll encounter during the course of the project. By the time you start to work there, anything that needs moved should have been moved, but it's still a good heads up what you'll need to keep an eye on if you're on the excavator, stinger, knuckle boom, etc.

Questions

1. Who designed the project?

2. Who is the responsible charge engineer?

3. What is the future average daily traffic count?

4. What station does the bridge begin?

5. What station does the bridge end?

6. What station does the project begin?

7. What station does the project end?

8. What Magisterial District is the project in?

9. What utilities are we encountering?

10. What sheet can we find detour cross sections on?

Chapter 2 General Notes

Believe it or not, there's not a lot to say about this sheet. This one is one of what we call our "standard" sheets. That just means that it's basically the same sheet in every plan set, no matter what kind of bridge. There are provisions for steel, concrete, and wood, different types of decks, clean and paints, etc. The most important information is the "Governing Specifications" and "Design-New Structures." Everything else, we either draw big "X's" through, or take them off if we need the note. If the note has an "X" drawn through it, you can ignore it. Otherwise, these notes will be the same for every project. We vey rarely add a special note, but try to refrain because that defeats the purpose of calling it "standard."

If you think of plans as a recipe and yourself as the baker, then the "Governing Specifications" is the cookbook we're using. It contains all the detailed information about standard things that go into our bridge. For example, the Standard Specifications Roads and Bridges 2017 explains what "Class B" concrete is. It explains what "Select material for backfill" is. It gives minimum thicknesses for coatings like paint and galvanization. The "2017 Standard Specifications Roads and Bridges" and it's addendums are our governing specifications and it is commonly referred to as the "Spec Book." If you would like to check one out, they're available online at https://transportation.wv.gov/highways/contractadmin/specifications/2017StandSpec/Documents/2017_Standard.pdf

We might have an extra laying around the office somewhere too. It's not a bad idea to have one in each crew cab in case questions arise.

Questions

1) What design strength for Class B concrete (f'c) is specified under "Design-New Structures"?

2) What subsection do we use to cure "Concrete (Cast-In-Place)" in accordance with?

3) Are we using the note for "Reinforcing Steel Bars" for this project?

4) Where do the reinforcing bars go?

5) Are we using the "Cleaning and Painting (Existing Structures)" note for this project?

6) Why or why not?

7) How far outside the neat lines of the footing are we to take the Structure Excavation limits?

8) Do we need the "Maintaining Traffic" note for this project?

9) Why or why not?

10) Can you think of a time we wouldn't need the "Maintaining Traffic" note?

Chapter 3-Existing Elevation and Deck Section, Estimate of Quantities, and Scope of Work

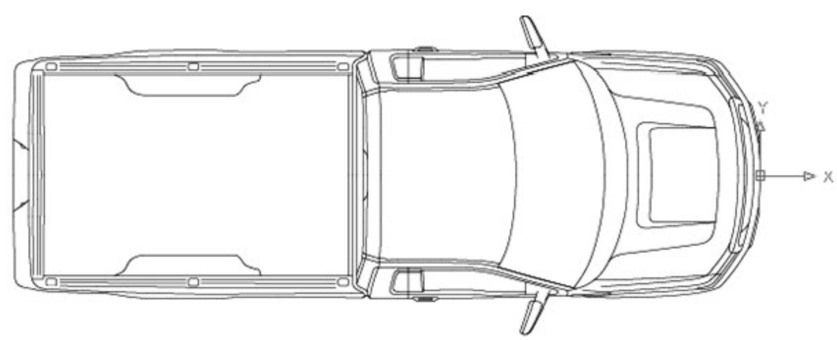
We've been thinking about the plans as a recipe to bake a bridge. If we continue with this thought, Chapter 3 represents the ingredient list and mixing instructions. This sheet typically has three main parts. First, we have the estimate of quantities. This table summarizes the estimated amount of every material necessary to build a bridge. Box beams, concrete, reinforcing bars, pavement, etc. Anything that we need, within reason, should be included in this summary. Second, we have the "Scope of Work". This is a very condensed set of instructions that presents the general order of operations in constructing the project. The third part is the existing elevation view and existing deck section. These are shown for comparison's sake. They're really just inspection sketches of the structure we're planning to replace. But while we're on the topic, let's take a minute to talk about the views we'll find in a plan set.

Let's talk about the plan view first off. Makes sense since we're talking about plans ehh? A plan view is simply an overhead, or birds eye view of the project area. Everything we're using has been reduced to a horizontal plane which we are viewing from above. We use plan views extensively later on in the plan set to show overall project layout.

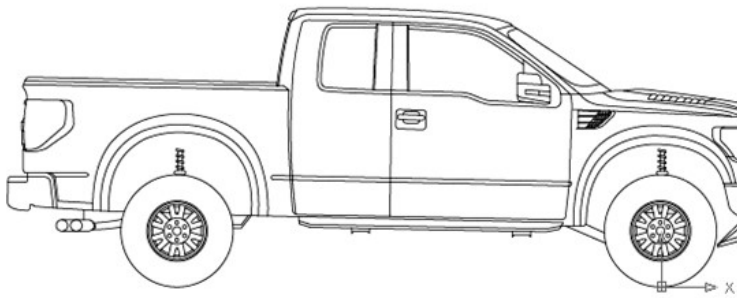
Elevation views are side views. Think about standing in the creek and looking a bridge side on. That's an elevation view. It's also important to note that it's outside the structure, but more on that in a bit.

Section views are just what they sound like. You're trying to show a section of something that may be hidden by other things. On our example plan set, the "Existing Deck Section" shows a view that is normally hidden. We show it by removing the abutment. It can be thought of as a slice of something. Similarly, we'd view a section of an apple by splitting it with a knife.

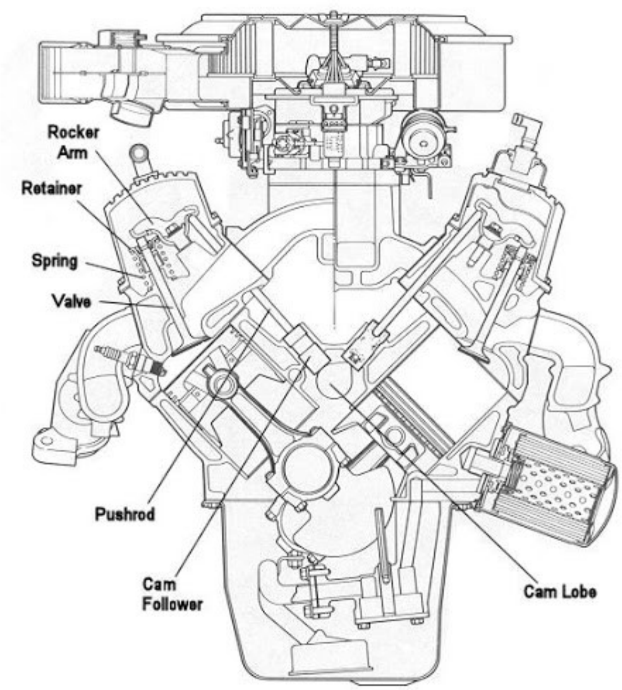
Here's a plan view of a Ford F-150



Elevation view of a Ford F-150 Raptor



Here's a Section view of a pushrod engine:



Hopefully those three pictures did a better job of explaining it. Once you get these three views wired up in your head, it's pretty simple to combine three 2 dimensional images into 3 dimensions.

Questions

1) What's the very first step in this project?

2) What is the overall length of the existing structure?

3) What is the horizontal clearance of the existing structure?

4) How many cubic yards of Class B concrete are needed?

5) How many pounds of #5 bent rebar is needed?

6) How many pounds of #5 straight rebar is needed?

7) How many pounds of #8 rebar is needed?

8) How many pounds of #6 bent rebar is needed?

9) How many rolls of Antirock waterproofing membrane are needed?

10) What size are the 16 swedged anchor bolts?

Chapter 4 Right of Way Ownership Index and Utility Table

This is a tough sheet to understand without a little background information. A right of way is legal right, established by usage or grant, to pass along a specific route, through the grounds or property of another. Technically speaking, the State of WV doesn't own the property the right of way is granted through, just the right to pass through it. With that comes rules the actual landowner has to follow such as no impediment of traffic, no permanent structures, etc. There are some roads, like the old turnpikes, that we do own land and all, commonly referred to as ownership in fee. The main gist is this, there are different types of right of way, and it doesn't necessarily mean the state owns anything other than the right to use the property.

Usually when we talk about buying right of way, we're talking about what's called a "Permanent Right of Way." It's denoted in the table as "R/W." This is the typical, plain Jane definition of right of way, the right to pass over someone else's property. We can also purchase "Temporary Construction Easements," which only allow our use of the property for a limited time and only to store equipment or materials. This time is usually the life of the project. When we're done using it, it reverts back to the landowner free from right of way restrictions. Thirdly, we purchase what's called a "Permanent Easement. "This is a permanent right of way *over* water. We also buy "Temporary Easements." This easement works just like regular T.C.E., but only for the life of the project and it's over water. An example of this is when we purchase a T.E. from the DNR to put in a temporary bridge. We have to acquire a temporary right of way (easement) for the section of stream and streambed that we're crossing over. If we relocate or widen the permanent structure, we'd purchase a P.E. for that.

This sheet summarizes all of our right of way purchases, details them with reference to the owners, gives the tax map and parcel numbers, and gives deed books and page numbers. It also repeats the utilities we encounter on the project and further details them by giving their station of interference and their disposition. The station of interference is really just the measurement along the centerline of roadway in which the utility is in the way, and the disposition is what we want done with it. Some can be relocated permanently while other can be moved temporarily. Others, power lines for example, can be deadened the day the crane in on site.

Questions

1) What station does the power line start being in the way?

2) What station does it run to?

3) Does it need to be relocated permanently?

4) What station does the telephone line interfere at?

5) Can the telephone be relocated temporarily?

6) What is the deed book and page number for parcel 1?

7) How many square feet of right of way are we purchasing on parcel 1?

8) How many square feet of right of way are we purchasing on parcel 2?

9) Are we purchasing a T.C.E. on parcel 2?

10) How many square feet of T.C.E. are we purchasing on parcel 1?

Chapter 5-Project Plan View

All pages in a set of plans are important and necessary. But if you were in a bind, and needed one sheet with the most information, this is the sheet you'd pick. With a scale, you can make a proper estimation of about any other dimension you'd need. This sheet details the centerline of roadway in great detail; it shows what are called the cardinal stations, which are the ones that are deemed most important for the alignment (another word we use for centerline of roadway). Makes sense, right? It shows all the right of way information as far as what we own, what we're purchasing, and references them all to centerline of roadway (again, alignment). It shows the power lines, the telephone lines, the poles, the pole numbers, the trees that get removed, the limits of foundation protection, and any homes or buildings. It details the detour alignment as well.

There's another thing on this sheet that is of vital importance. It shows the location and coordinate values for the survey control points. The function of these points is described in their very name. They are the mathematical control for the entire project. That is; the entire project is based on as few as three points. It is absolutely necessary that these points not be disturbed. You may have even witnessed an engineer throw a fit over one these points not too long ago. If you do disturb one, absolutely tell someone. Better yet, if you need to disturb one, let someone know in advance, and the point will be moved or another set. An ounce of prevention is worth a pound or maybe ten pounds in this case. We absolutely have to have two points. So, if we have a project with three and two are destroyed, the project is over. Period. Every coordinate, measurement, angle, and dimension you see on the plans is based on these simple iron rods with plastic caps.

Questions

1) How many control points can you find on this plan sheet?

2) What station does the T.C.E. end at?

3) What is the right of way width on County Route 22?

4) How many trees can you find?

5) Do any trees need removed?

6) Is there a house shown?

7) Is there a vacant school house?

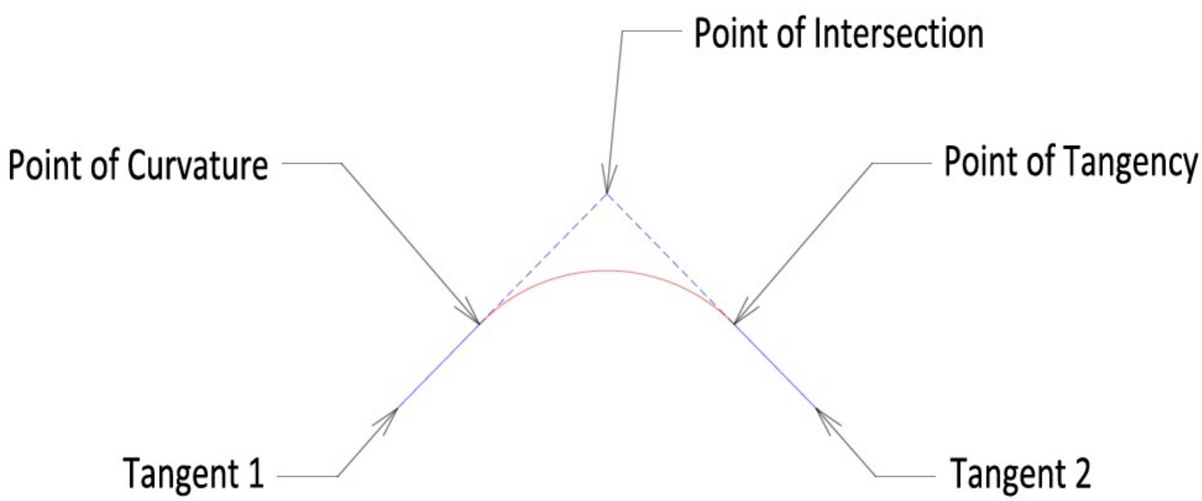
8) What is the Northing of #DOH-2?

9) What is the Easting of #DOH-2?

10) What is the elevation of #DOH-2?

Chapter 6-Survey and Alignment Data

This sheet looks a bit like a repeat of the previous sheet. But it really just builds on it. It again shows all the survey control points (starting to get the idea they're important?), it shows the alignment stationing again on however many alignments are needed. One additional thing this one shows is what's called the "Alignment Data." In short, this data is a numerical representation of the centerline you see on the plan view. To dig a little deeper; alignments are made up of tangents, which are straight lines, and curves which are, well, curves. These alignment data tables break these alignments down into individual components; tangents and curves. It gives the direction and length of the tangents to orient them correctly then the radii and lengths of the curves. At the end of a curve, a new tangent starts, and so on until we get the point of end or POE. Now, remember those cardinal stations we talked about a while back? Here's where they get important. You see, when a tangent ends and a curve starts, that's an important one, so we call it a PC or point of curvature. The next cardinal point is the PI, or point of intersection. This one defines a point used in constructing the curve along with the radius. The next and final point of a horizontal curve is called the PT or point of tangency. Each curve has three parts, PC where it starts, a PI which is essentially the middle, and the PT where it ends.



Hopefully the diagram makes it a little clearer.

Questions

1) How many different alignments are shown on this sheet?

2) Can you tell what each one is for?

3) What is unique about each alignment's stationing?

4) How many county routes are shown with an alignment?

5) How many curves are found in the mainline alignment?

6) What do we call the point where an alignment starts?

7) What do we call the point where an alignment ends?

8) What do we call the point a tangent ends at and a curve begins?

9) What do we call the point a curve ends at and a tangent begins?

10) What station is the point of tangency at for curve 1 on the mainline alignment?

Chapter 7-Property Map

At first glance, this sheet looks exactly like the previous two, only maybe not quite as crowded. You can see that a bunch of the alignment junk is gone and several labels are missing. This is a sheet that's done pretty much for the right of way folks, but include it in the construction plan set because there's still a lot of data on it. The main point of this sheet is to show property ownership. It's important to remember here, this information is not based on a boundary survey We put it together with courthouse information only. In the rare event we actually pick up a property corner, we take it into account, but it's still not a boundary survey. This is really just to show how we've determined, to the best of our abilities without a boundary survey, who owns what around our structure. That line you see running around the house and building on the far right with the "PL" on it is a property line. We were able to plot out the deed and fit it adequately enough to prove what we thought the owner was correct. The lines are unremarkable, but they represent a phenomenal amount of work that starts with the surveyors and ends with the right of way folks. It takes no less than three people to get that line in the right place, and at times, many more.

Questions

1) Who owns parcel 1?

2) What’s the deed book number for parcel 1?

3) What’s the tax map and parcel number for parcel 1?

4) How many acres are in parcel 1?

5) Who owns parcel 2?

6) What’s the deed book number for parcel 2?

7) What’s the tax map and parcel number for parcel 2?

8) How many acres are in parcel 2?

9) Does parcel 2 cross County Route 22?

10) Did we perform a boundary survey to place the property lines?

Chapter 8-Traffic Control Plan

There's been a lot of state force work that we don't put this sheet into, but we probably should. Although many folks don't see traffic control as a priority, the truth is, it's the single most important aspect of the job. These signs keep traffic off you. Use them. We are hopeful these sheets will make things easier on everyone involved. Although the drawing is to scale, the signage is not. Therefore, each distance is clearly marked. This sheet shows the signage used in a typical bridge replacement with a temporary detour structure. These sheets should also line up with cases given in the Manual for Uniform Traffic Control. If you don't have one available, let someone know. This manual in particular should be available to everyone. This sheet should be pretty well self-explanatory.

It is imperative that we get these traffic control plans set up correctly in the field. Not following these plans creates huge safety issues as well as liabilities that we don't want to incur. It is a legal requirement that we do this correctly.

Question

1) Are the traffic control plans important?

2) Is it important that we get the signage correct?

3) Are these sign a legal requirement?

4) Do we have our own traffic control book?

5) Is the 2017 Standard Specifications Roads and Bridges referenced on this sheet?

6) Are the signs placed according to scale on the drawing?

7) Will every project require this same setup?

8) Can you think of any type of construction project that wouldn’t require signage at all?

9) If you’re flagging, does the flagger sign need to be out?

10) How many signs are required for this job with no flagger?

Chapter 9-Profiles and Typical Sections

The profiles and typical sections sheet can be thought of as the project grade control. The profile view you're looking at for C.R. 22 is representative of taking the entire alignment and straightening it out. It's like a section of the elevation view of the whole centerline of roadway. We use the profile on the design side of things to make the horizontal and vertical alignments jive with each other. We put both final grade (in dark print) and original ground elevation (in light print) on each profile. Once we've set final grade, we can work our way back down and determine things like where the toes of fills will end up. You see the profile in a finished set of plans as final grade. Along with cross sections (taken perpendicular to centerline of roadway), you could lay out the entire roadway in three dimensions. When you're first starting to think about the different views, the profile view and the cross sections are probably the easiest pieces to look at and fit together in your head. They fit together like a spine and ribs with the profile being the spine and the cross sections being the ribs. You'll also notice on this sheet that there's a vertical alignment or profile for every road involved in the project. There's County Route 22, which is mainline, County Route 16, which is the intersecting route, and the detour route. There is also what we call a "typical section" to go with each profile. A typical section is self-defining; it is a snapshot of what most of the cross sections will look like. It gives typical pavement thicknesses for wearing and base as well as the required thickness of the base course, fill, and fabric if any is required.

Questions

1) How many different profiles (vertical alignments) are on this sheet?

2) How many different typical sections are shown?

3) What is the elevation of C.R. 22 at station 0+50?

4) Is the existing elevation the same at station 0+50?

5) What is the “Begin Bridge” station on the profile of C.R. 22?

6) Does it match the “Begin Bridge” station shown on the cover sheet?

7) What do you think the PVC means on the profile of C.R. 22?

8) What station on C.R. 16 does it tie into C.R. 22?

9) How thick is the wearing course on C.R. 22?

10) How much base does the detour section get?

Chapter 10-Proposed Bridge Plan View, Post Tensioning Rod Details, and Guardrail Details

Page after page devoted to the layout of the road and the landowners, and finally we get to some real bridge details. Although some really good details are found on this one, if you look a bit closer, you'll see some familiar items. You'll see not only a station to begin the bridge and end the bridge, but you'll find a new station for the intersection of centerline of bearing and centerline of roadway. In this example, centerline of roadway is also centerline of bridge, so their intersection is marked by station and coordinate value. There's also a finish grade elevation that will echo what we saw in Chapter 9.

We've spent a fair amount of time thus far talking about centerline of this and centerline of that, but there hasn't been much explained. It's fairly obvious that the centerline of the roadway is the line that represents the center of the new alignment. It's also reasonable to see that the centerline of structure is the middle point between upstream and downstream with regards to the bridge deck or superstructure. But what exactly do we mean when we say "centerline of bearing"? First, know that on a box beam structure, centerline of bearing is 9 inches from each end. Centerline of bearing is the point where the weight of the live load (traffic) and the dead load (self-weight) of the superstructure pass into the substructure. Structural analysis is all about distributing the load. A bridge's job is to pass load into the ground, and it does it through centerline of bearing. That why shortly you're going to see an overall beam length followed by a span length. They're different because the span is only measure from centerline of bearing to centerline of bearing.

With that little exercise out of the way, another look at sheet 10 yields more information. We can see the guardrail post layout spacing for the superstructure and see what the measurements are from each end to the post. We can also the post tensioning rod spacing on this sheet. Just like the guardrail post spacing, a measurement from each accompanies the bar spacing so we can orient everything to the end of the beams. Throw in the approach guardrail details and that should finish this sheet up.

Questions

1) How many post tensioning rods are required for this bridge?

2) How many beams are there?

3) How many guardrail posts on each side?

4) How deep do you think the beams are?

5) How many buffer ends are required to complete the job?

6) How many Asymmetrical Thrie Beam Transitions are required to complete the job?

7) Is it necessary to show the centerline of roadway for C.R. 16 on this sheet?

8) Why or why not?

9) What is the scale of this drawing?

10) Are upstream and downstream clearly marked on this drawing?

Chapter 11-Side Mount Guardrail Details

There is a lot of information on this sheet, but it's all about one thing. Guardrail. This sheet is the one the box beam manufacturers will use to place the anchor bolts inside the beams when they cast them. Granted, most of us don't really feel like guardrail is all that important, it is required by law. With that said, this sheet is a great exercise in continuing your exercise in figuring out views. Look around the sheet and try to make sense of what it's telling you. Look at how the washer details fit back into the side elevation view of the post anchor detail.

Questions

1) What are the dimensions of Plate Washer C?

2) Which plate washer is between the post and the side of the beam?

3) Is Plate Washer C cast into the concrete?

4) How long is the guardrail post?

5) How long is an Asymmetrical Thrie Beam Transition?

6) What purpose does it serve?

7) Do the upper guardrail post attachment bolts get coil ferrule insert?

8) What do they get instead?

9) How thick is Plate Washer A?

10) Could the side elevation view also be called a section view in reference to the box beam?

Chapter 12-Elevation View, Hydraulic Data, Structure Excavation Details, and Proposed Deck Section

More bridge details!! This plan set is starting to look like something now! The first thing we notice at the top of the sheet is the elevation view. Thinking back to our views, this makes perfect sense now. You can see the overall length dimension (that's the measurement from back of backwall to back backwall), the overall beam length (which we've already discussed), and the span length. Now that we know the beam length and the span length are two different things, that dimension make a lot more sense. If you look a little closer at the elevation view, you'll also notice there are details for the rock berm we build with the foundation protection material. Here you'll see that we build a 3' wide berm in front of the abutment then drop to the stream at a 2:1 (2 feet horizontal to 1 foot vertical, a nice, workable slope). We can also see from the elevation view that the depth of the foundation protection material (FPM) needs to be 2 feet. These numbers will vary by project. The depths are set by what's called gradation of the FPM.

Gradation is just a fancy way of saying size. Underneath the elevation view is a little box titled "Gradation of Abutment Foundation Protection Material." We could talk a lot about gradation and what those D100 through D15 mean, but this is the box that sizes your FPM. In looking, we see that the D100 Min is 2.0 and the Max is 2.2. That tells us that 100 percent of our material being used should be 2 feet in diameter or smaller. If we think back to having a 2-foot-deep apron, that makes perfect sense. Similarly, the D15 says 0.5', or 6". This tells us that very little (15%) of our FPM is allowed to be less than that 6".

To the immediate right of the FPM gradation box is the hydraulic data. Here you can find some important details, especially if someone from the public happens along. They may ask you, "Do you know how much water this thing is designed to handle?" Knowing where the hydraulic data is, you can comfortably answer, "Yes sir, it's designed for a Q-10 event with a discharge of 355 cubic feet per second!" Those Q numbers are a fancy way of talking about a design storm, or the amount of water we have to design the structure to pass. For this bridge, we used a Q10 event, or a ten-year storm, and its discharge is 355 cubic feet per second (or 2655.6 gallons per second). This is a common event for our structures because of their size and ADT. We choose the design event based on the ADT. A ten-year storm means that "this much water happens about once every ten years." It's a statistical thing, but statistics aren't real math, so we don't give them much merit. You could have 10-year storms back to back to back in a week, it's just statistically unlikely. Anywho, similarly, we have a Q5, Q25, Q50, Q100, and a Q500. We sometimes design for a Q25, but rarely anything higher. We do however have to limit the amount of water that the structure is allowed to back up. We call that, unsurprisingly, backwater. We limit ourselves to zero allowable backwater during the Q100 storm event. Sometimes this is very difficult for us to achieve. Sometime in the future, if you're looking at a 20-foot-wide creek and wondering why we're building a 50-foot bridge, this is the likely culprit. As an aside, it's widely accepted that the 1985 flood in West Virginia was a Q500 in the central part of the state, while it was estimated by some to be a Q1000 in the Eastern panhandle.

Below the hydraulic data you'll see the "Proposed Deck Section." Technically we could call everything in these plans proposed, but this is another great reminder to brush up on your view comprehension. This is a cross section of the bridge. It shows the overall width as well as the horizontal clearance. If we didn't have to have some type of guardrail, there would only be need for one number, but because the guardrail encroaches on the section, we have to have both. You can see that we lose

5.25 inches just from the guardrail. This drawing will also show things like cross slope if any is meant to be present, wearing surface thickness again (we don't use base on a bridge *unless* it's an arch), the construction gaps, and a callout for the guardrail details.

Over yonder to the left of the proposed deck section is the "Structure Excavation Detail." If you look back up at the elevation view for just a second, you'll see a callout circle at abutment 1 that says "See Detail A." This drawing is Detail A. It is a section view of the elevation view above, scaled up so we can see more detail. There's also a lot of information here to chew on. You can see that the size of the beam is noted as well as the bearing pad details. It's more apparent here than anywhere else in the plans that the centerline of bearing and centerline of the abutment are two distinct lines. You can also see the details for the preformed joint filler we get with the beams. It's always somewhat of a hog roping when we cut them all loose and joint filler goes flying everywhere. This drawing, along with a couple others later on, can make that process a lot smoother. Another very important part of this one is the "Select Material for Backfill." Select material for backfill is so important that it has its own section in our spec book.

> 212.2 Materials
>
> Select material for backfilling shall be crushed stone, gravel, slag, or any combination thereof meeting the requirements of 703. The grading shall be such that 100 percent of the material passes the 2-inch (50 mm) sieve and 0 to 5 percent passes the No. 16 (1.18 mm) sieve. Any of the standard coarse aggregate sizes from AASHTO No 4 through AASHTO No 8 as shown in table 703.4 would comply with the gradation requirement.

If you do a little more poking around in the spec book, you'll see that Table 703.4 refers to coarse aggregate gradations. This means, like in the above description, the fines are limited. It's because this stone is intended to be used as a drain. Crush and run will not work, it does not drain. It's not the same, stop using it behind backwalls. We commonly refer to clean stone generically as "57 stone." This is in reference to an AASHTO designation for AASHTO 57 stone, which is blended and open graded. If we have AASHTO 57s in the stockpiles, it's fine to use it, it meets the requirements for select material. But, so do some other stones, as long as they're clean (open graded). This information is all available in the spec book. We prefer clean 1 ½" stone, but any open graded stone meeting the size requirements is better than something with fines.

If you're interested, here is the gradation of AASHTO 57 stone:

AASHTO #57 coarse aggregate stone has 100% passing 1 1/2" screen, 95-100% passing 1" screen, 25-60% passing 1/2" screen, 0-10% passing #4 screen, and 0-5% passing #8 screen as per Figure 1 below.

AASHTO #	4"	3-1/2"	3"	2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#50	#100
1	100%	90-100%		25-60%		0-15%		0-5							
2			100%	90-100%	35-70%	0-15%		0-5							
24			100%	90-100%		25-60%		0-10	0-5						
3				100%	90-100%	35-70%	0-15		0-5						
357				100%	95-100%		35-70		10-30%		0-5%				
4					100%	90-100%	20-65%	0-15%		0-5%					
Area #4				100%	90-100%	60-90%	10-30%			0-1%					
467					100%	95-100%		35-70%		10-30%	0-5%				
5						100%	90-100%	20-55%	0-10%	0-5%					
56						100%	90-100%	40-85%	10-40%	0-15%	0-5%				
57						100%	95-100%		25-80%		0-10%	0-5%			
6							100%	90-100%	20-55%	0-15%	0-5%				
67							100%	90-101%		20-55%	0-10%	0-5%			
68							100%	90-102%		30-65%	5-25%	0-10%	0-5%		
7								100%	90-100%	40-70%	0-15%	0-5%			
78								100%	90-100%	40-75%	5-25%	0-10%	0-5%		
8									100%	85-100%	10-30%	0-10%	0-5%		
89									100%	90-100%	20-55%	5-30%	0-10%	0-5%	
9										100%	85-100%	10-40%	0-10%	0-5%	
10										100%	85-100%				10-30%

AASHTO 57 stone is a combinate of AASHTO 5, AASHTO 6, and AASHTO 7 in this chart.

Questions

1) Do we use crush and run as select material for backfill?

2) Why or why not?

3) Is select material for backfill open graded?

4) What does open graded mean?

5) Why is select material for backfill open graded?

6) Will AASHTO 57 stone work as select material for backfill?

7) Why or why not?

8) What is the design discharge for this bridge?

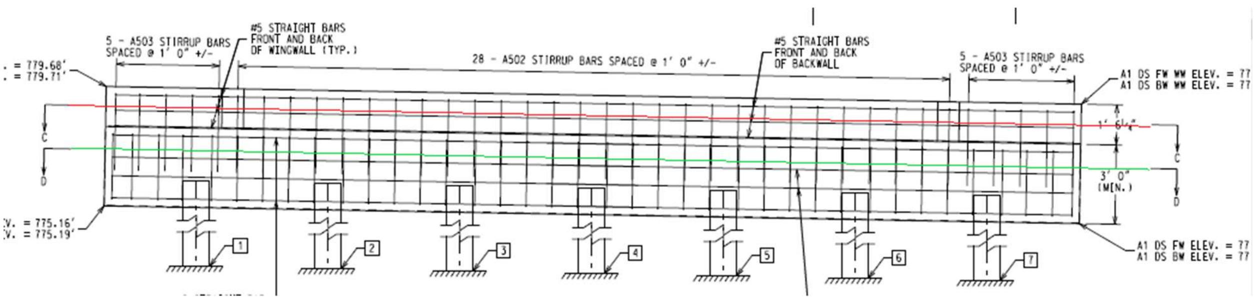
9) What is the design storm event for this bridge?

10) Do we want our select material for backfill to drain water?

Chapter 13-15 Abutment Details

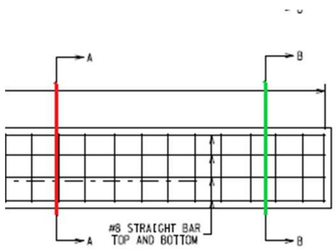
Woo hoo! Another sheet where our view knowledge is important! You'll also notice that this isn't a single chapter, rather three of them. That's because these three pages can be explained at the same time. Sheet 13 is the detail sheet for abutment one, while sheet 14 is the same for abutment two. Sheet 15 is the abutment rebar and typical section sheet.

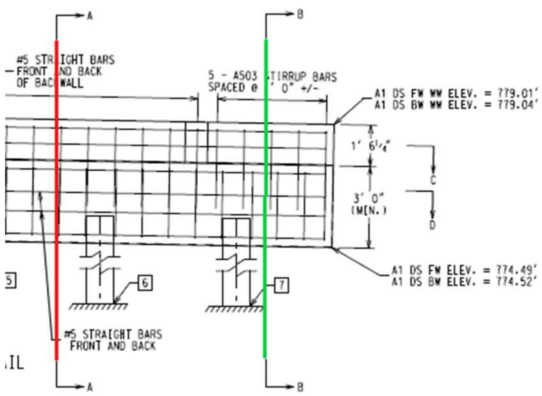
We can see straight away on page 13 that there's a plan view of the cap, an elevation view of the entire abutment, and two section views, one of the back-wall and one of the cap. If you look closely, at the abutment elevation view, you'll see a "C" and a "D" with an arrowhead that makes a 90° bend. You'll notice on the other end of the abutment, there's a matching one. Now, look at the non-arrowhead ends, and pretend to draw a line from one to the other (C to C and D to D).



Now, look up yonder, between the elevation view and the plan view detail. See Section C-C and Section D-D? Those are the sections you'd see if you look along those lines in the plan view. Hopefully by now you're comfortable with how all these are separated out. There are a lot of different ways to look at things. In a complete set of plans, we try to look at every aspect necessary.

We can also see the beginnings of some reinforcing bar, or rebar, details. Here in a bit, we're going to talk about some of the primary forces that an object might experience, but for now we're say that concrete is very strong in compression. Don't believe it? Try to squeeze a piece until it breaks. You can't. Now, while concrete is super-duper in compression, it's terrible in tension. That's the point of using rebar, the steel absorbs the tensile forces that would otherwise destroy the concrete. These first two abutment sheets are the beginning of laying the steel out properly. If you look at section D-D, you can see that it specifies 4 number 8 bars, top and bottom. It also shows number 5 bars, front and back. We know that this is just for the cap (3' x 3') portion because that's all section D-D shows. Add to that the 38 A501 loop bars, and you can see in your mind roughly how the cage should be built for the cap. Now we need to take our skills to the next level. Look to the right side of the elevation view and section D-D. You'll see a section line for A-A and for B-B. Section A-A is in the section for the part of the abutment with the beam seat and backwall. Section B-B is the portion of the abutment with the wing. Regardless, do the same that you did with C-C and D-D; draw an imaginary line:





Now, carry those images over to sheet 15. Working between these three sheets seamlessly is probably one of the most crucial parts of the entire project. It is imperative that the rebar be placed accurately because it has a job to do and needs to be in the right place to do it.

Let's talk about a few other things on the abutment detail sheets. If you look again at the elevation view, you'll notice that the piles are shown, and they're labeled. Keep in mind that this view is *facing* the abutment, so pile 1 is upstream and pile 7 is downstream. Take a gander over on the right-side margin of the sheet and you'll see a little chart there. Actually, there are two little charts, but we're interested in the one that's titled "Abutment #1 Pile Coordinates and Cutoffs." The numbers listed in the chart probably don't mean much to you, but those are the x-y coordinate vales the surveyors use to stake them out. Each set of numbers represents the mathematical center of the piling based on the control points for the project. The pile cut off elevations shown next to the coordinate value is the elevation the pile needs cut at to achieve the embedment specified in the plans. There will be a sheet explaining how to use a level at the end of the plan reading stuff. Everyone on the job should know how to set up a level and use it to determine if something is correct or not.

There's a box above the piling coordinate box that didn't used to be on our plans. We used to assume that the piling would be driven straight and then we built everything off of the pile line. That was a great theory. But in practice, it's easier to use the centerline of pile and the centerline of bearing to make sure everything works together as we start building up out of the mud (don't forget the 57 stone!). This chart also contains coordinate values for the abutment corners. The surveyors might be the ones laying it out, but you should know what these are and what they're used for. Ask a surveyor and they will more than likely teach you how to stake them out.

There's really only one more topic to discuss with these abutment layout sheets, provided you understand the views. Every plan, elevation, or section drawing either has dimensioning used to layout or it calls out rebar. If you examine the "Abutment #1 Cap Plan View" on Sheet 13, you'll see that all the dimensions necessary to layout the form work are found here to base it on the pile locations. It's all really very simple when you slow down and take it piece by piece.

Considering that Sheet 14 is exactly the same thing for Abutment #2, we're not going to devote any more time to it. As a matter of fact, we're not going to spend much time on Sheet 15 either. The drawings are just detailing for the previous two sheets, and many times are typical of both abutments. The real meat and taters part of Sheet 15 is that it lists ALL of the rebar used in the abutments in what's called a "schedule." That's just fancy talk for break down. If you take a peek at the rebar schedule, you'll find that, like everything else in this set of plans, it's broken down, itemized, measured, numbered, and counted up. It's a summation of all of the rebar designated and detailed in the past three sheets. We're not going to go over every type of rebar or every shape, but this schedule is a good basic explanation. Look at the Mark A501 bars. You'll see that's a type 2, which is a loop bar as shown by detail to the right. The measurements are also available in between looking at the detail and the chart. You'll see that a Mark A501 loop bar uses 10 feet 6 inches of #5 bar. A number 5 bar weighs 1.043lbs/ft. You can also see that we need 76 of them for the total project. Soooooo…… with a little mathin', we need 832.3 pounds of A501 bars. This is an important chart, because we purchase rebar by the pound, and this give the fabricator the detailing necessary to bend each shape. It works the exact same way for every other piece of rebar in the structure, even the straight bar.

Questions Sheet 13

1) What is the pile cutoff elevation for pile 6?

2) Is pile 6 closer to the downstream end of the abutment or the upstream end?

3) How many A502 bars go in the backwall?

4) What is the spacing of the A502 bars?

5) How many A501 bars does abutment #1 take?

6) Are the A501 bars in the cap or the backwall?

7) Are the A502 bars loop bars or stirrup bars?

8) Are there any other kinds of bars in abutment #1 besides loop, stirrup, and straight?

9) How far should it be from the last pile to the bulkhead of cap form?

10) Is the centerline of bearing shown on all three plan views on this sheet?

Questions Sheet 14

1) What is the abutment #2, front, upstream seat elevation required?

2) Is pile 9 closer the upstream end or downstream end?

3) Are the bent bars in Section C-C the same bars used for abutment #1?

4) How many #5 bars are in the backwall, front and back?

5) How many A501 bars does abutment #2 require?

6) Are the A503 bars stirrup bars?

7) Are the A503 bars used in abutment #2 the same bars used for abutment #1?

8) How many A503 bars are need in abutment #2?

9) Do the A503 bars go in the backwall?

10) Where do the A503 bars go?

Questions Sheet 15

1) How many A502 bars are necessary for the whole project?

2) How many feet of rebar does it take to make an A501 bar?

3) How many pieces of #8 bars are necessary?

4) What is the total weight of #8 bars needed?

5) What is the total weight of #5 straight bars needed?

6) What is the total weight of the #5 bent bars needed?

7) How far does the W12X65 piling get embedded into the cap?

8) How tall is the cap?

9) How wide is the cap?

10) How tall is the backwall?

Chapter 16-22 Superstructure Details

The next 7 sheets deal solely with what we call a "prestressed post tensioned concrete box beam." As far as building the bridge goes, there's no reason to pour over these sheets and study them, although there are some handy drawings like Sheet 21 where you can see a bearing pad and foam layout. These are the sheets the box beam manufacturer uses to build the box beams. Instead of talking in-depth about each and every sheet, we're going to talk a bit about what these beams are and maybe a bit of nerdy stuff while we're at it.

In order to figure out just what in the world these box beams are, we're going to have to talk about a few other things first. We've talked about two forces already, tension and compression. You know that tension is the force that's trying to pull something apart and compression is the force trying to squeeze something together. Very few things experience only one of these forces however (except trusses!). In addition to these two forces, there's another that we call moment. Weird name for a force huh? If you've ever had to use a cheater pipe on a ratchet to break a lug nut loose, then you've used this force. Some people generically call it torque. Anywho, if you were to take an 8' long store bought 2"x4" and put each end on a block, then step up and stand in the middle, you would see it bow downward. From the side, it would look like a smile. What's happening here is your weight is inducing a moment inside of the 2"x4". The bottom of the smile is the tension side, and the top, where your feet are, is in compression. That's essentially how a bridge works to pass load from the superstructure to the substructures.

Now that we've talked about the world's shortest, crappiest bridge, let's think back to our concrete box beam for a minute. If we just built a concrete beam to span the creek, that should work, right? Well, if you remember way back, we talked about concrete only being good at one thing. Compression. So those tensile forces in the bottom when it's loaded would likely cause the concrete to fail. We could just add rebar, but at some point, even that idea starts to break down. There's only so much room to add steel. To solve that problem, when they make these crazy box beams, they stretch super high strength steel strands through the forms (called beds), then place all the rebar. They set the bulkheads for the forms, with holes drilled in the correct pattern to let the super steel pass through (Sheet 16 shows the pattern if you're interested). One end of the steel is fixed in big anchors while the other ends are hooked up to a big hydraulic jack. The super steel is around 120ksi, which means it will take about 120,000 pounds per square inch before it starts to deform (we typically build bridges out of 50 ksi steel). The jack takes it up to a little over half its strength, sitting at about 70,000 psi (this "initial pull" is found on Sheet 17). While those strands are under that enormous load, they pour the beds full of concrete. The highly stressed strands along with the rebar and Styrofoam filled voids are all covered up. When the concrete has cured long enough to get the required compressive strength, some dude comes along with a torch and pops those wires on the jack side. All of that enormous amount of stress is snapped into the concrete like a rubber band. The catch here is that the steel *compresses* the concrete. So, the beam humps up now because all that tensile force just became compressive force and it's pushing the beam together from its ends. But concrete likes compression. The concrete is so highly compressed that during its life cycle, the bottom of the beam should never be in tension due to mere traffic load. This is the "prestressed" part. We gather up the ones we've ordered, get them shipped out to the job, and set them. After they're set, we put the big silver rods through them and tighten them up good that way too. This is the "post-tensioned" part. Post tensioning causes them to act together as a unit instead of separate beams.

Questions

1) What do tensile forces do to a material?

2) What do compressive forces do to a material?

3) Is torque the same thing as moment?

4) What strength steel do we typically use to build bridges?

5) What is the strength of the prestressing strands used in box beams?

6) Do they stress them to the max? Or about half way?

7) Have you helped build a prestressed post tensioned concrete box beam bridge?

8) What are your thoughts on how they work?

9) Do you think they're an economical option for us?

10) Would you like to see where they're made?

Chapter 23-26 Cross Sections

Well, here we are… The very last section (pun intended). We're going to do the same thing as the last chapter and combine a few pages of plans into one chapter. We've already talked a good bit about what views are and how they work together to build a three-dimensional image of our plan set. Cross section sheets represent the roadway, which is what our customer, the public, sees. For the most part, ol' John Q. Public doesn't care a lot about the nuts and bolts of a project. He doesn't care how much time we took to survey it, or design it, or the amount of care we took to get the piling in the right location, or that we used 57 stones for select material for backfill. Ol' John cares about the final product. More specifically, as a wise operator once passed on, John Q. Public wants it pleasing to the eye and smooth to the butt. Beyond that, he doesn't care.

We're first going to look at Sheet 23. In the bottom part of the title block, you'll see that this sheet is 1 of 2 for C.R. 22. You may recall that C.R. 22 was one of our three alignments for this project. Typically, if there's an alignment shown on Sheet 5, you can expect to see cross sections for it later on in the plans. Looking at the data on the sheet, you'll should notice six individual rectangles. Each one has a label underneath it and that label correlates it to the station on the alignment. Just above the station label, you should see a zero. That zero point represents the alignment, or backbone, just like the profile view. Everything to left and right are offsets, marked in feet. Because we're tying in at Sta. 0+50, let's slide up and look at Sta. 1+00.

Looking inside the rectangle now at Sta. 1+00, you see again that the zero line is labeled "CL Roadway." To the right, you'll see "9.5' RT. R", "11.0' RT. S", and "13.0' RT. T". These labels represent the offsets from centerline of the edge of road (R), the edge of shoulder (S), and the toe (or bottom) of slope (T). Look down towards the bottom of the sheet to the right of the scale, and there's a list of what all the abbreviations stand for. Back to Sta. 1+00, you can see the same sort of descriptions to the left. From these few numbers we know how wide the pavement is supposed to be, how wide the shoulders are, and the total width of the roadway. If you look at the bottom of the grid, you'll also see an elevation that corresponds to every point of interest. So, we have all the offsets, descriptions, and elevations in one neat little package.

That's really about all there is to them. Nothing magical or difficult, just the minimum information necessary to build it the way it needs built. There will be some things here and there that show up and look strange, but only if the section actually cuts through it (Sta 1+50 for example cuts through part of the abutment). But if you look at the plan view, it should be pretty easy to follow what's happening.

Questions

1) What is the centerline elevation of C.R. 22 at Sta. 1+75?

2) What is the right offset for the edge of roadway at Sta 1+25?

3) What is the left toe of slope offset at Sta 1+25?

4) What is the elevation of the left toe of slope at Sta 1+25?

5) What appears on Sta 2+00 that's not roadway?

6) What is the centerline of roadway elevation for station 10+50 of C.R. 16?

7) What's showing up on the far right of Sta 10+75 on C.R. 16?

8) What is the offset for the right toe of slope at Sta 20+25 on the detour sections?

9) What is shown on Sta 20+50 of the detour sections?

10) Has this packet been of any use to you?