

## **BRIDGE DESIGN AND CONSTRUCTION FROM THE COUNTY PERSPECTIVE**

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### **INTRODUCTION**

There are 3 parts to having a successful county bridge program. These 3 parts are 1) financial, 2) developing a plan and 3) actual bridge construction (implementation of the plan). These parts are separate but dependent upon one another. The amount of money available for a comprehensive county bridge program will determine the plan and the setting of priorities. The cost of bridge construction will dictate the level of plan formulation and amount of money required. For instance, lowering bridge construction costs would either result in less overall funding being required or a more comprehensive plan being developed.

As the financial involves to a large part of county taxes, which is a sensitive subject, let's first look at the source of funding for a county program. Most counties in Indiana would use the Cumulative Bridge Fund, although supplementary monies could be available from CAGIT, CEDIT, Cumulative Capital Development, or other sources. For this paper, I will assume most bridge funding on a county level comes from the Cumulative Bridge Fund.

Below are 4 definitions from Indiana Code, 8-16-3-1.5 regarding the Cumulative Bridge Fund:

1. Bridge means any structure designed to carry vehicular traffic over or under an obstacle to the normal flow of traffic and including any grade separation, culvert, or approach to a bridge.
2. Approach means any part of a road or street which is required to make a bridge a viable part of a county road or city street system but which does not extend more than five hundred (500) feet from the bridge.
3. Construction means both construction and reconstruction to a degree that new, supplementary, or substantially improved traffic service is provided and significant geometric or structural improvements are affected.
4. Cost means all expenditures required to construct, maintain, or repair a bridge, including engineering, equipment, land acquisition, materials, contracts, and bond interest.

It is still not very well understood how broad these definitions can be. A bridge means any culvert, even a 12" or 15" culvert on a gravel road. Approach means 500' on either side of a culvert. That's 1000' (plus the size of the culvert) of approach paving legally allowed on a 12" culvert on a paved road. Also, a new culvert does not need to be installed to do approach paving.

This means that technically, if 6 culverts per mile were on a paved road, that the whole road could be repaved using Cumulative Bridge Funds **WITHOUT REPLACING ONE CULVERT!** Also, all stone fill, labor, equipment, etc. would qualify for the use of this funding.

The Cumulative Bridge Fund can also be used to pay for the inspection of all bridges and culverts in a county, including those less than 20' in length. These inspections must be supervised and approved by a professional engineer registered in Indiana.

By knowing the limits of the Cumulative Bridge Fund, an overall comprehensive county bridge program can be developed. A county bridge system includes structures from a 12" culvert to major river crossings hundreds of feet in length. All individual parts must be addressed. The three major areas are culverts (including round and flat bottom culverts, multi-plate, aluminum box, concrete, etc), single-span bridges (typically 20-75' in length) and multi-span bridges (most often the category for federal aid projects).

Here are some guidelines I have developed for each category. First, for all categories, the structure size and type must be determined. Structure size is usually proportional to drainage area. The larger the drainage area, the more opening required. The more opening required, the greater the cost. Also, the longer the bridge length (or span) the greater the cost.

CULVERTS - This is the least expensive of all types of bridges.

1. Washington County has since 1987, specified Aluminized Type II culverts for long life and economy. This type of material adds 15% over the regular price of galvanized culvert, but over a life cycle has overall lower costs.
2. Construction should be one piece. Usually 50' length is the maximum one piece available. Putting a band in the middle of the road is not recommended.
3. Flat bottoms are specified only when height is a problem. A round culvert is cheaper than flat bottom for the same opening size.
4. Occasionally, tank can culverts are used where the site has high velocities and low cover on the culvert.
5. Aluminum box culverts are occasionally used where the foundation is not rock for structural support. For a fixed overall available height, aluminum box culverts will have more opening area than a flat bottom, but also cost more.
6. Other types of culverts, such as multi-plate, steel arch, concrete box are used due to special requirements at a specific site.

Many existing smaller bridges and even some over 20' in length can be replaced by culverts. An existing round culvert can be replaced with a flat bottom or aluminum box for more opening area for a fixed available height.

### ONE SPAN BRIDGES

1. Our county crews can build 1-2 substructures per year average. If the substructure is built with county crews, using precast box beams on the deck will in most cases result in a satisfactory job.
2. Used precast box beams are available from contractors and the Indiana Department of Transportation (INDOT). The usual length is 30-40'. Try to get 4' wide, if available.
3. The county can do much of the approach work such as hauling stone (and riprap), grading, some fill, and even paving.
4. Only contract out work that the county cannot do.
5. Always monitor the contractor, especially during critical times such as foundation work, concrete pours, etc.

### MULTI SPAN BRIDGES

1. Consider federal aid but sufficient lead time is required. A typical time from the start of the project (design or preliminary engineering) to construction starting is 4 years.
2. Always compare federal aid to county only including all costs, including design, construction, and construction supervision. County forces may be used during the construction supervision (engineering) phase to monitor the contractor.
3. Generally, the county will be limited in involvement, except for administration of the contract.

Some general problems I have seen on county-wide bridge programs are that counties 1. may neglect culverts and single span bridges in favor of "more spectacular" larger federal aid type projects and 2. a few counties in Indiana have millions of dollars in their Cumulative Bridge Funds and bridge approaches going to the dogs. These counties should consider putting \$100,000.00 or \$200,000.00 in a Cumulative Bridge Fund line item a year for "approach paving" and going to work!

### PLANNING

I feel that a well planned program is the critical first step in getting a practical county bridge program in place. It is nearly useless to have \$3 million in immediate bridge needs on a \$200,000.00 per year budget. A practical bridge program cannot be developed under these circumstances. This planning may require more than the minimum necessary to get the federal bridge inspection report completed, but is within the program guidelines. I would urge counties to have the preparer of the county federal bridge inspection report to go into depth in planning, even if additional cost is required. Remember 80% of this cost is paid by the FHWA. This would be a sound investment for all levels of government.

The county bridge inspection reports have a wealth of data. Counties can have bridges listed in order from shortest to longest, narrowest to widest, and lowest load limit to highest. By looking at all 3 sets of tables, one bridge that may have a low load limit may also be a short and narrow bridge. A short bridge costs less generally to build than a long one. Thus, this bridge may be a good selection for repair/reconstruction at an early date.

Should a bridge with SR of 50-80 on a higher volume route be replaced before a bridge with SR less than 50 on a remote route? What about replacement time required with a federal-aid type project? what small bridge/culvert needs does the county have? what condition is the road system in at present? How much overlay work is needed? All of these questions would affect a county bridge program.

Should:

1. long, remote bridges be closed, repaired, or replaced with county only funding or federal-aid?
2. bridges in the range of 30-100' be replaced with county only funding?
3. more work be done in repair, widening, maintenance, etc?
4. low water type structures be replaced with bridges or culverts?

These are difficult questions to answer and require a lot of thought. As counties make progress with their bridge program, planning still remains a key element. for counties that have made limited progress, planning is a critical element.

Finally, the bridge inspection report must be accurate. Destructive testing is allowed to be part of the report, although it does increase the total report cost. This may be useful on old steel trusses and especially pony truss bridges where I have found that Federal Highway Administration (FHWA) guidelines for steel strengths can be too conservative. Also, old concrete and slab bridges have been grossly underrated, and technology is now available to remotely determine reinforcement size and location in these structures. Again, this takes a higher cost, but it may reduce some of the unfortunate replacement jobs I have seen.

As there is a lot of judgment in these bridge inspections reports, a number of counties have a policy to rotate the contract over the years between different parties. There is no restriction on getting a second opinion on a particular bridge at any time, using county money. A few thousand dollars spent on planning up front can save a \$50,000.00 - \$100,000.00 expenditure at a site that, while having a need, may not have an immediate need.

#### Cumulative Bridge Fund Review:

Indiana law for the Cumulative Bridge Funds allows counties up to \$0.30 per \$100.00 assessed valuation. Nearly every county in the state has this fund in place. The average county brings in around \$300,000.00 per year from this fund.

What may not be well known is that this fund has broad application, by law. A bridge is any structure, even culverts, grade separations, etc., and it includes all costs, including signs, guard rail, approach paving, shoulder work, etc. Repair and rehabilitation are a fully allowed use of this fund.

Shown below is a general program for a typical county:

Bridge # 20	Federal-Aid Design	\$	20,000.00
Bridge # 40	Federal-Aid Construction		80,000.00
Bridge #100	County Design & Construction		40,000.00
Bridge #110	County Design & Construction		60,000.00
	A -Bridges not on an inventory		10,000.00
	B -(less than 20' length)		10,000.00
	C -County Design & Construction		10,000.00
Culverts			30,000.00
Approaches			10,000.00
Safety (includes signs, guardrail, etc.)			10,000.00
Repair			20,000.00
		\$	300,000.00

In Washington County, after years of building major structures, we were at a point where there was a backlog of culverts and small structures with critical reconstruction needed. Yet, all money for these small type of projects was coming from the Highway Department general funds, not Cumulative Bridge. And, more remote federal-aid bridges were planned. We cancelled three of these remote federal-aid bridges, including one with federal-aid in the preliminary engineering phase, and used our Cumulative Bridge Fund as a source of money for this small structure type work.

Not only did this get some critical work done, but approximately \$30,000.00 average per year in MVH Funds could go towards the critical need of asphalt overlay. When this overlay money was tight, the highway department was slow in putting in culverts when using MVH Funds, but greatly accelerated this construction when using the Cumulative Bridge money. The basic situation was that we had money to build a remote \$750,000.00 federal-aid bridge but no money to replace a \$2,000.00 collapsed culvert on a main route.

As counties move toward better bridges, the Cumulative Bridge Fund still will remain an important source of money for bridge work, as allowed by law, but perhaps on a less spectacular basis. Culverts, guardrail, painting, maintenance, etc. is not like building a new bridge but this is critical work and money is needed for it. If funds are not available from the Cumulative Bridge Fund, money will need to come from the general highway fund (MVH & LRS) or other sources which reduces critical paving and other work. Nearly every county in Indiana is short on asphalt construction/reconstruction.

## CONSTRUCTION:

Once the entire county is reviewed, a practical plan developed, and steps taken to implement this plan within the financial capabilities of the county, then it's finally time to start building some bridges. The purpose of this section is to present some ideas to work in economy that have come from our experiences in Washington County and along with numerous discussions with county engineers, superintendents, contractors and commissioners. This is by no means a complete list and other ideas can be added, which would make a useful resource tool for all of us.

On federal-aid bridges, it is fully legal for counties to tell the INDOT when they would like to let (bid) the project. Certain times of the year may result in a lower cost to the county. A project let in December-March is on the average going to have lower bids than on let around June-August. Also, although the INDOT has fairly rigid specs, all county federal-aid projects have "special provisions" which can modify these specs, resulting in an equally satisfactory project, but at a lower cost.

Likewise, on a county only funding project, counties can adjust bid dates for economy. This does require some knowledge of INDOT work in the area and discussions with local contractors. If the INDOT has just let a number of projects, a county job may not have a low bid, but if some INDOT jobs are finishing up, the contractors may be looking for work, and thus lower bids obtained.

Counties can bid jobs with a wide range of options. For instance, a bridge job can be bid with county crews hauling and placing a backfill, paving approaches, and installing guardrail. Also, multiple contracts can be used. For instance, on Bridge 115 replacement, we had a contract for the precast box beam superstructure, one for the substructure, and county crews placed fill, guardrail, etc. This resulted in a 150 foot long bridge, 22' wide and over a major river, being completed in a short time for \$118,000.00 complete.

At times, used concrete box beams are available from the INDOT auctions or contractors. These are being used with increasing frequency on state bridge jobs with runarounds. Generally, the price is 40-60% of new, although state auctions have sold sets for pennies on the dollar. This does require some knowledge of county bridge needs, which relates to planning and the use of data in the Cumulative Bridge Report. For instance, if 13-50' beams are available, where can they be used? If a good buy comes up, schedules may need to be adjusted. Also, money needs to be available.

Contractors can be contacted before bidding on state jobs with runarounds as if the beams have a market after the runaround is torn out this may affect the contractors bid.

These beams are generally 30', 40' and 50' in length and in odd numbers. However, along with new bridge construction, they are useful for widening jobs.

Related, a lot of used guardrail, and posts, both galvanized and aluminum, is available. Counties can buy direct from contractors who generally are replacing this guardrail on state jobs. Quality varies, but good used guardrail can be purchased for \$1.00/ft. and 6"x6"x6'3" posts for \$15-10 each. Also, aluminum posts and rail for near the scrap price.

In the design phase, a number of jobs satisfactorily use old stone abutments for part of the substructure. I have seen this not only in many parts of Indiana but also in Kentucky and Tennessee. Can a bridge be widened instead of replaced? If so, can used precast box beams or steel beams, etc. be used?

As mentioned, there are numerous ideas to reduce construction costs, and the above is no way complete. The important item I feel is that a county find the right blend of techniques to get as much done as possible. It is critical that counties with limited funds to be as creative as possible to get as much done as possible. This generally requires planning and direct involvement of county officials and personnel in the county bridge program.