SKELLY AND LOY, INC.

PROGRESS & THE ENVIRONMENT

April 1998 Volume 2 No. 1

"OLD" TECHNIQUES FOR STREAM RELOCATION DESIGN

We know what you're thinking! This is a copy of Skelly and Loy's **PROGRESS & THE ENVIRONMENT**. So in a publication that has the word **"PROGRESS"** in its title, why am **I** reading about something that is "old"?

The answer is that this is really about a "new" application of something that is as "old" as the hills, or rather, the rivers that run through them. We are talking about fluvial geomorphology (say that three times real fast). Fluvial geomorphology (FGM) is the study of how natural stable streams and rivers are formed. The reason we say "old" is that nature has been doing a fine job creating stable streams and rivers long before mankind ever dreamed up a name like fluvial geomorphology. It just took us (the engineering community) a little time to figure out how nature was doing it.

Traditional Design Approach

For decades, traditional hydraulic engineering approaches have been used for sizing stream channels when stream relocation efforts have been necessary. These approaches have been based on various hydraulic computer programs and models to design channel cross sections and slopes that could pass the required regulatory design storm such as the 2-, 5-, 10-, 25-, 50-, or even 100-year storm events. As highly trained engineers, we know that the shortest distance between two points is a straight line and that smooth (low Manning's "n") channels are the most efficient at moving huge amounts of water. Consequently, these design criteria tend to result in smooth, straight, high velocity channel designs which require extensive bank and channel bottom stabilization techniques. Concrete, rip-rap, gabions or other expensive approaches are often required to protect the channel bottom and sides from the highly erosive velocities which can often develop.

The irony of the situation is that many bridges and channels designed using these techniques often require ongoing maintenance to remove accumulated sediment and other debris which begin to settle out and reduce the hydraulic capacity of the channel. Why does this occur if we have such high storm flows?

The answer comes from fluvial geomorphology. Based on years of detailed studies of the dimensions, patterns, and profiles of naturally formed channels, these studies have shown that, in nature, the main channel of a stable stream has a hydraulic capacity to pass storm events ranging from approximately 1.1- to 1.8-year return period, a much smaller design storm than that used in traditional engineering approaches. This flow level is referred to as the "bankfull" condition. These more frequent storm events have the ability to maintain the balance between natural channel scour and sediment deposition processes, thereby resulting in a stable, self-cleaning channel. While severe flood events may transport large amounts of sediment, these events occur on a relatively infrequent basis. In contrast, the total cumulative tons of sediment transported by the more numerous 1.1- to 1.8-year design storms are much more significant than the single, low-frequency major flood event.

Therefore, the reason for the sediment deposition in large, traditionally designed channels is that the smaller "work-horse" storms cannot maintain the larger cross-sectional flow areas designed to handle the more severe storm events.

FGM Design Approaches

In applying FGM principles to channel and bridge designs, the approach is to provide a smaller primary channel to handle the bankfull design storm event. These bankfull channels maintain their ability to transport natural sediment loads generated by the watershed, thus preventing a sediment deposition problem. The smaller bankfull channel cross section results in a reduced project cost by reducing bridge span and opening size.

The additional hydraulic capacity required to handle the more severe design storm events is provided outside the bankfull channel on the floodplain areas where the existing vegetation provides more than adequate protection to handle the lower velocity flows which occur in this region of the channel. At bridge crossings, these floodplain flows are transmitted through culverts or other openings referred to as flood flow pipes set at the elevation which corresponds to the top of the bankfull channel. These flood flows can be handled safely in these shallow depth areas as long as the velocities can be maintained below permissible velocities for the existing vegetation in these regions of the channel. Sediment loads carried by these floodplain flows are much less than the bed loads transported in the bankfull channel. This lower sediment load can be more easily transported through the flood flow pipes without the risk of deposition.

In nature, many stable stream types exist without consuming extensive flood-prone areas. Duplicating these stream types for bridge designs reduces the number of flood flow pipes required and further improves the economics of using a FGM design approach. The FGM approach also minimizes much of the cost associated with traditional channel protection efforts and reduces the required bridge spans. Also, it has the additional benefit of being able to incorporate aquatic habitat enhancement structures and improved project aesthetics.

ROSGEN Stream Type Classification System

When working on designs which involve natural systems such as soils or groundwater, it is important to know the **types** of soils or geology which exist in the project area. In a similar manner, to use FGM principles in a design, it is equally important to know what **stream type** is involved. This information provides valuable insight into the design process by understanding the general characteristics and attributes of streams within a given group.

Named for its developer, David Rosgen, the Rosgen stream classification system uses FGM principles to categorize natural streams into eight major type categories. This classification methodology has been published in his book entitled "Applied River Morphology". Stream type is used as a basic design tool to begin to determine physical stream channel geometry, bed slopes, and other detailed design parameters. It is also used to determine the suitability of various types of aquatic habitat structures which can be incorporated into FGM designs. Using a natural channel design approach, aquatic habitat can be incorporated into a project design while still maintaining project costs below the comparable traditional channel construction costs due to the savings in reduced cost of rip-rap or other traditional revetment efforts.

So what do you think? Does this sound like **"PROGRESS"**? If you need a little more time to ponder the question, take your kids to a good fishin' hole and see what they think.