Making connections - by Chris Rollins

Local materials and simple technology are enabling Ethiopians to build vital bridge links between their communities. Chris Rollins explains how a US charity is making this possible.

Local labor and materials can be used to build sustainable, cheap bridges for remote communities.

As the sun lowers over the highlands in central Ethiopia I survey the Joregeta Valley: Belie, my lead mason and a former artillery captain, barks orders to the crew with the tarp covering the last course of masonry for the night. Negussu, fresh out of high school and anxious for his college admission results, manages some fifty villagers and donkeys moving stone from the river up to the piers. Mebratu, the engineer, is nearby at the excavation for our next bridge directing the villagers with their picks and shovels. Richard, a volunteer from Silicon Valley, manages sand washing in the faint stream that will soon be a torrent when the summer rains arrive. I squat in the falling sunlight with my calculator and a fresh cup of Tella and make my next quantity list and schedule. This is construction work village style, and we are building bridges.

In December of 2000, Ken Frantz was reading an article in National Geographic about rafting the Blue Nile River, when he saw a photo of villagers crossing a broken masonry bridge by means of a simple looped rope. He was so moved by the image that he traveled to Ethiopia to survey the problem, and within a year he installed a new steel truss over the missing masonry span with the help of American engineers, Italian fabricators, and American and Ethiopian labor.

Realizing how desperately many parts of the world need such inexpensive crossings, Bridges to Prosperity was born from a passion for helping poor communities to build their own bridges in an inexpensive and technically feasible manner. Following the success of this first bridge rehabilitation, Ken went on to rebuild several other bridges in Indonesia and Nepal with his own money and the generous donations of several individuals and organizations.

In October of 2002, I was reading the same magazine when I saw the article about the repaired Sebara Dildi Bridge over the Nile. I contacted Ken with an offer to volunteer my engineering and construction experience on a short-term project, just as he was looking for an engineer to join the existing program manager, Zoe Keone, for a six month trip to Nepal to study the Helvetas pedestrian bridge building system and launch this idea in Ethiopia. It sounded like a straightforward plan, and so I bought my ticket and headed for Kathmandu.

Helvetas Nepal is a Swiss operation with Swiss and British funding and Nepali staff, and it manages a very successful bridge building project: hundreds of bridges are completed every year across the country, local labor and materials are maximized, and an efficient network of trails now links the nation during the summer monsoon season. (Bd&e issue no 35). This highly refined system appeared perfect for translation to a country such as Ethiopia, which also shares a predominantly rural, mountain-dwelling population, as well as a debilitating summer monsoon that isolates many communities from schools, hospitals, and markets for months of the year.

The transfer of technology is never easy, however. While Nepal enjoys a gainful position between the great civilizations of China and India, Ethiopia has historically been relatively isolated by massive deserts to the north, west, and east, and malaria-bearing lowlands to the south. The Nepalese are masters of masonry, as much of the country contains easily-dress-able limestone, while Ethiopia is predominantly basalt, a rock which fractures randomly and is incredibly hard; hence the stonemason's tradition is not widely known here. Bridge building came easily to Nepal from China, but this kind of structure is unfamiliar in Ethiopia, and foreign ideas are often not immediately embraced or even fully understood by isolated, uneducated people.

None-the-less, Bridges to Prosperity has already built five new bridges in Ethiopia in the last eighteen months, and two more are currently under construction. At a cost of roughly US$300 per linear meter, many more communities will eventually benefit from permanent crossings suitable for people and livestock, at a cost that is an order of magnitude cheaper than a vehicular bridge. And through the bridge building process, they also gain new skills in construction, surveying, and project management that can be used for more sophisticated undertakings such as dams and irrigation systems.

Pedestrian bridges suitable for rural areas are of three main types: truss, suspension, and suspended. While a truss can effectively span up to 32m, the cost of design and fabrication is often prohibitive, and skilled erection labor - rare in rural communities - is also required. Suspension bridges also require complex fabrication and construction procedures that are beyond the scope of most villagers, who often do not even have high school education.

The bridges most suitable for rural applications from 20m to 200m are of the suspended, or hanging, type, because they maximize locally-available materials such as rock and sand, and the only prefabricated materials they require are the cable, deck panels, and cross-beams.

Suspended bridges are limited to terrain with relief, of course. They sag approximately 1/20 of the span distance and require at least 5m of freeboard in most cases, so these bridge types are best suited to mountainous areas where the channel is surrounded by topography on either side. In some situations, a large pier can be built in areas without exceptional relief, but fortunately many suitable sites exist in central Ethiopia.

Suspended bridges in the 20m to 120m range use cable combinations from 26mm to 36mm diameter, as with suspension bridges, but they have shorter towers that are less than 4m high. These towers can be constructed of locally-available stone, allowing the villagers to contribute labor to the construction process, if not money. Anchorage systems can be either a concrete beam with a dead load, in soil foundations, or rock-anchored concrete drums. Cement requirements are minimized in both cases by building mortared masonry walls with dense rubble infill, using as little as 7500kg (150 x 50kg bags) of cement for the entire structure. When all materials have to be mixed by hand, numbers like this truly matter.

Steel cross-beams 1m wide and steel deck panels 340mm by 2m can be fabricated in nearby towns and transported to the site by jeep, donkey, or porter. Other materials, such as reinforcing bars, cement and hardware, are likewise portable and can be installed with relatively few tools and minimal skills. On several of the bridge projects, key crew members had never seen a wrench before, or turned a bolt. Simplicity of design and construction is crucial when people are starting from basic abilities, but the opportunity to teach them new skills is likewise remarkable.

Masonry is the main skill necessary for suspended bridge construction, and this can be taught quickly to even the most uneducated work force. Most of the work is repetitive, allowing the new masons to perfect their skill as the structure rises from the foundation toward the walkway. The village children invariably take over the smaller tasks such as tying rebar and smoothing mortar joints, and in every group one or two people will embrace stone dressing as an art form. As work progresses, the feeling of pride among the community is unmistakable, and with this pride comes empowerment and opportunity.

The process is not without problems, of course. Materials are often inferior. Clean sand might be impossible to find, and by the time enough is mined from the riverbank for construction, no water is available in which to wash it. Labor strikes and disputes are the same as anywhere else in the world. Labyrinthine government bureaucracy can slow construction for days while the cable or parts clear customs. Material prices fluctuate rapidly, turning some cost estimations into random guesses. And in some places, too many handouts from foreign agencies have made communities so accustomed to welfare that they are unwilling to work for themselves. But each of these problems has a solution, just as they do in the industrial world, and learning to manage and compromise in a foreign culture is perhaps the greatest task in the Bridges to Prosperity mission.

For now, Bridges to Prosperity Ethiopia is operating with one foreigner on the staff in the country; the goal is to make this program entirely Ethiopian. In order to better integrate this system into the existing technical services offered by the local Ethiopian government, Bridges to Prosperity is now teaming with Helvetas Ethiopia to train local technicians and carpenters in this unique structural form, and to make the system part of the existing Rural Roads Authority agenda.

Although this may slow the current pace of construction, in the long term it will make the program accessible to more communities. With greater funding it will be possible to undertake more ambitious suspension bridge projects in the southern lowlands. In these regions people routinely wade through crocodile and Schistosomiasis-infested rivers like the Wabi Shabeli, 80m wide and 1m deep, to get to a market or a health clinic.

Bridges to Prosperity has also secured funding to initiate bridge building in the South American Andes in the coming year. Although the difficulties of a new culture will likely be entirely different than those in Ethiopia, Bridges to Prosperity is ready for the task with the same passion and persistence that worked in Africa. Soon we will have new local staff in a new country, and more remote areas of the globe will move a step closer to the education, health care, and financial opportunities that so many of us take for granted.

For more information about volunteering or donating to Bridges to Prosperity, please contact Ken Frantz at kfrantz@bridgestoprosperity.org

Dessie Bridge

The 42m-long Dessie Town Bridge was the second bridge constructed using the Nepal system in Ethiopia. Because it was a semi-urban setting, some materials were purchased that would be mined or gathered for free in a more rural location. This site was chosen to test the program incrementally in a less remote location than later bridges.

Local contribution:

- 74m³ stone for masonry
- 18m³ broken stone
- 8m³ gravel
- 56m³ sand
- 355 pieces chisel-dressed stone
- 85 mason-days
- 150 laborer-days

Program contribution:

- 154 bags cement
- 26mm cable x 300m
- 2200kg cross-beams and deck panels
- 180kg reinforcing steel and saddles
- Two months' survey, design, and on-site supervision
- Miscellaneous tools and hardware

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