Bridge DESIGN & ENGINEERING

Leap of faith

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A style of footbridge first developed for use in the Himalayan region has now been adapted for a project in Kenya

With a span of 112m, the structure is considerably longer than others built by the charity

Children in Bombi in eastern Kenya will now be able to get to school without the danger of being attacked by crocodiles or hippos, thanks to a new crossing built by the charity Bridging the Gap.

Construction of the Bombi footbridge over the Galana River was completed in June, and it sets a new standard for footbridge construction in rural Africa. It is the first structure of its kind outside of the Himalayan region and is located approximately 80km west of the coastal city of Malindi near the Tsavo East park road.

At this point, the river is a meandering flood prone channel populated by large crocodiles and hippos. The new bridge links a school and agricultural lands on the north side of the river with a clinic and rural road on the south side, and it will prevent countless deaths due to crocodile and hippo attacks, especially among children. It will also promote the local economy by allowing local farmers faster and cheaper access to market.

The bridge was built by Nairobi-based charity Bridging the Gap with funding from the Presbyterian Church of East Africa and engineering support from Bridges to Prosperity of the USA. The original request was put to the church by the local people, who wanted a secure means to cross the unpredictable and dangerous waterway. The church approached Bridging the Gap, which has a history of successful bridge projects in rural Kenya.

The charity was founded in 2003 by US native Harmon Parker. Trained as a master mason, Parker first came to Africa in 1985 to build a home for missionaries in a remote part of the Democratic Republic of the Congo. He was drawn to Kenya in 1990 with his wife and three-year-old son, and he built a school in Kitale before making his first venture into bridge construction in 1996. He started building bridges in response to the overwhelming need expressed by local Kenyans, particularly Masai in the southern Mara region and Pokot in the north near Turkana. Now teamed with welder and construction supervisor Sylvester Ouko, Parker has built more than 40 bridges throughout the country.

Kenya has a yearly wet season with frequent flash flooding in otherwise dry or shallow channels, and most of the charity's footbridges are on seasonal paths in areas with few hippos or crocodiles. At an average cost of US$5,000, Parker's bridges are designed to be cheap, so that as many as possible can be built with limited funding. "My goal is to improve the quality of life for as many people as possible," says Parker, "by lessening their daily foot-travel burdens and reducing the risk of losing family members due to drowning and predation." The BTG hanging bridge is an empirically-designed structure which has limited engineering input. With its maximum span length of about 45m, it is sufficient for many crossings in the arid regions of the country. Additionally, the simple design allows fabrication with basic tools and repairs can sometimes be made by the local authorities.

For all bridge projects, Parker requires community involvement throughout the process. All requests must come from the village level, villagers are required to participate somehow in construction, and even the poorest communities must contribute to financing the structure. “If all they can manage is just one goat, they have to give something for the bridge,” says Parker. This local effort can be especially demanding in traditional pastoralist communities such as the Masai and Pokot, whose cultural concept of work is very different from that in developed countries.

The locally-hired crew for the Bombi Bridge was described by Parker as “the best team I have worked with in Kenya”. Traditionally elephant hunters who were pushed out of Tsavo Park when it was created in 1948, the Gariama and Watta have struggled for both an identity and a livelihood in modern Kenya, where hunting elephants is now illegal. Though their traditional lands were expropriated for tourism and conservation, they received no benefits or compensation, and sixty years of economic and political neglect has left them truly marginalised. Orma people from Somalia are more recent arrivals to the area around the bridge site; pushed south by drought, war, and economic collapse, these herders put additional demands on the land, especially near the ever-flowing Galana.

As a solution to these numerous problems, the Presbyterian Church initiated a school, clinics, and 20 irrigation projects in the area in the hope that education might lessen inter-tribal tensions, and agricultural surplus, as well as growing cash crops, would stimulate a local economy. The bridge effort came as a natural extension of these efforts, to provide a means to safely cross the river all year, particularly for young children, and as a route to market for produce-laden bicycles. However, getting from idea to reality was not an easy task – not least because the span required to cross the river was some 112m.

Derek Roulsten of PCEA approached BTG in early 2007 about the project. Undaunted by the proposed bridge’s size and location, Parker accepted the challenge, but finding a suitable design delayed the project considerably. Engineering students in the USA were enthusiastic and willing to help, but without the requisite footbridge design experience and no understanding of the limitations of construction in rural Africa, this avenue made little progress. Parker then approached Ken Frantz of Bridges to Prosperity, an international non-governmental organisation dedicated to footbridge building in the poorest corners of the world. Ken shared the same enthusiasm for the project, and he had experience with such efforts in East Africa, as well as a network of experienced engineers ready to help.

By late 2007, the project was almost a year behind schedule and still no start date was in sight. On a chance evening layover in Nairobi, Bridges to Prosperity board member and structural engineer Chris Rollins met Parker for several hours to discuss the situation and rank various alternatives based on existing projects and designs around the world. Because the estimated span was far beyond anything previously built in the region, the Helvetas Nepal modular N-type suspension bridge design was chosen for the project. This design is well proven in Nepal, and plans could be handed to the steel fabricator almost immediately. Rollins remained active throughout the project, making three trips to Kenya at critical construction times and providing sometimes hourly engineering support by SMS and email; Robert Groeli, the former programme manager at Helvetas Nepal, also gave key advice to the team.

The Helvetas N-Type bridge is a modular design which was developed for transport through the Himalayan mountains using porters and donkeys. The heaviest element of the bridge - aside from the wire rope - is only 64kg. Towers, deck panels, and cross-beams are built up from simple plates, rods, and angle iron pieces. Through the momentum of 20 years’ sustained effort in Nepal, fabrication costs and complexities are manageable in Kathmandu but this was not the case in Nairobi. The first fabricator accepted the plans and delivered a bid, but at the time of signing announced that additional fabrication drawings were required before work could start. David Engineering of Nairobi finally accepted the contract, but with over 20,000 individual parts and 13t of steel, monitoring the fabrication process and maintaining quality control from a tented camp near the bridge site was impossible for Parker, and this required many weeks away from the construction site.

The final cost of the 112m-long Bombi Bridge was just over US$100,000, 40% of which was fabricated parts and wire rope. Four main cables of 32mm diameter support the deck, anchored to a dead man beam in sand/clay on the south bank and a pair of concrete drum anchors in soft rock on the north. The deck is 1.06m wide - sufficient for bicycles or loaded donkeys - with a pair of 32mm-diameter cables and two 50mm-diameter pipes underneath the cross-beams to stiffen it and provide lateral stability. The towers are 11m tall and are located on piers 3m above grade, and sag at dead load is 9m. Despite high winds at the site, no wind guys are deemed necessary with the standard Helvetas design under 120m.

With what now amounts to more than a decade of experience, Parker’s simple approach to bridge building is steadily evolving. Bridge requests arrive all the time and many cannot be satisfied by the shorter length and lower freeboard of BTG’s typical design. Furthermore, rainfall patterns are becoming more intense and unpredictable, requiring higher floodwater estimations and greater freeboard accommodation. Parker may have to expand his staff to meet existing demand, requiring standardisation for fabrication and construction to simplify the processes; this should also reduce unit costs and fabrication times as the organisation grows.

With the completion of the Bombi Bridge, BTG has moved up a magnitude of sophistication, but in the long term a blend of the elaborate Helvetas model and the simple BTG hanging bridge may prove the best solution to the rural footbridge needs that Parker is trying to address, where low-cost, simplicity, and quick construction times are paramount.

Rollins and Parker are developing a new design for a simple suspension bridge using the existing BTG steel shapes - 100mm and 150mm-diameter pipe - which will maximise the structural efficiency of the suspension bridge, while incorporating anchor, pier, and connection details from the Helvetas standard. These structures should start appearing before the next rainy season, and Parker will begin his next phase of building bridges for quality of life.

Bridging the gap

Helvetas Nepal

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