Trau Kod Dam Near Siem Reap, Cambodia: Sustainable Infrastructure in a Developing Community

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Summary
The New York City Professional Chapter of Engineers Without Borders has taken on a fast-paced project in Cambodia at the Balang Commune near Siem Reap, to be completed in January 2008. Working closely with a Cambodian engineer and a non-governmental organization, the team is constructing a privately funded concrete dam to replace an earthen structure that washed away during the rainy season of 2000.

As with much of Cambodia, this region depends heavily on the dam and adjacent reservoir for irrigation during the dry season. Since the dam’s failure six years ago, thousands of residents in the area have been relying on one growing season instead of two, and the economic effects have devastated the already impoverished region. This simple project will restore and improve upon the region’s irrigation system, leading to increased cropping intensity and higher total production, creating more demand for labour, and contributing to a reduction in poverty.

In addition to helping restore a sustainable local economy, the dam construction is part of a greater effort to empower developing communities to create tangible, positive change. Engineers have an opportunity to contribute their unique skill set to such projects, yet little guidance exists on how to proceed in an unfamiliar environment. This paper will provide guidance on issues unique to designing and coordinating a sustainable non-profit project in a developing nation, including the use of local materials and labour. The implementation of a maintenance and inspection program will be discussed, with the aim of training local staff to perform this work.

The paper will illuminate technical issues of designing and constructing a retrofit concrete dam adjoining to an existing earthen embankment, including issues of global structural stability, soil seepage, and relevant structural details. The construction phasing will be discussed with an emphasis on community involvement and transfer of technology. The larger irrigation system affected by the dam and reservoir restoration will be described, and the anticipated impacts on agriculture, commerce, and health of the community will be discussed.

Engineers Without Borders–USA (EWB–USA) is a non-profit humanitarian organization, partnering with developing communities to improve their quality of life by implementing sustainable engineering projects. By bringing together disparate volunteers, organizations like EWB can intensify the benefits and ensure the sustainability of projects like this one.

Keywords: Small dams; seepage control; improvised engineering; construction in developing nations; labour based construction; sustainable development.

Engineers working in developing countries face some unusual constraints (Fig. 1). In rural Cambodia, there was no electricity and very little infrastructure due to years of war followed by decades without maintenance. To resolve this lack of resources during a recent site visit, we created improvised engineering techniques using available materials. We discovered unique issues concerning the site, such as land mines in the area and structurally unsound bridges on the road leading to the dam. The design and construction methods were adapted to local conditions.

No site information was available to the design team prior to the visit. Investigations revealed the
The Trau Kod Dam was built in the late 1970's with forced labour as part of a Khmer Rouge irrigation project. Work was performed by adults under brutal conditions and directed by teenagers with no technical expertise. The dam has failed three or four times, always by overtopping. Each time it was repaired by community volunteers without proper material selection or compaction practices. No signs of slope instability were identified during the dam inspection despite considerable erosion at some locations. No sand boils were encountered, however one local resident reported substantial downstream flooding when the dam was operational, suggesting a seepage issue is present.

Precision engineering equipment was unavailable in Cambodia. We brought a scale, a number 200 sieve (75 µm), and a hand auger from the U.S. Other engineering tools were built from lightweight, portable, and easily acquired materials. During the construction phase, a second hand auger was fabricated at a local metal shop, along with a drop cone penetrometer and a drive cylinder for collecting undisturbed soil samples.

During the first days on site, the EWB team staked out a project baseline using a simple scope mounted on a makeshift tripod. In order to develop a rough site map, GPS data points were collected for the embankment, basin, and canals. Embankment cross sections were surveyed using an improvised levelling device [2]. Potential sources of borrow material were identified, including termite mounds, a typical source of clay in Cambodia. The EWB team developed an inexpensive method to generate aerial imagery, using Kite Aerial Photography (KAP).

The EWB design team has made it a priority to promote the transfer of technology. A small village can mobilize itself to form a skilled, sustainable workforce in the course of a single project, creating employment for subsequent generations. The construction phasing will maximize opportunities to train and use local labour during construction and annual inspections, and a contractor will be used only for the most technically challenging tasks. EWB's sustainable development goals include optimizing use of local resources and ensuring local beneficiaries will be responsible for maintaining the project in the long term [3]. The farmers who will directly benefit from this project will contribute their time and effort, with the hope that this will promote a sense of ownership within the community.

Phase one, implemented in early 2007, focused on repairing the intact portion of the 500 meter embankment, which had been severely eroded. A sand filled trench drain was installed to mitigate seepage issues. Work was suspended during the rainy season. Phase two will commence at the following dry season (late 2007), and will include repairing the existing canal system and installing culverts at locations where the canal crosses dirt roads. Construction will conclude with Phase three, during which a concrete water gate will be erected by a Cambodian contractor to complete the dam and provide a means to control the flow of irrigation canals.

Restoring the Trau Kod Dam at Balang Commune will lead directly to an improved quality of life for all the local residents. One of EWB’s subsequent goals is to teach people in the community practical skills through employment during construction that can translate to better maintenance of local infrastructure and dry-season job opportunities in Siem Reap. Local farmers will construct the dam and learn about materials selection and building techniques. They will acquire skills to make informed decisions, prevent erosion, and maintain the new dam and the area's other infrastructure.

References
[1] Photo by Tobias Rose-Stockwell.