Thesis Project Portfolio

K'ellu Mayu River Pedestrian Footbridge Technical Report

(Technical Report)

The Implementation of Structural Bamboo as an Alternative to Steel and Concrete in Developing Countries

(STS Research Paper)

An Undergraduate Thesis

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Executive Summary

Bridges are not only physical structures that connect one area to another. They connect knowledge and communities. Engineers in Action partners with students in different universities to design pedestrian footbridges in rural communities in developing countries. With global warming, a universal application of sustainable development is needed. A race to net zero development cannot exclude the lower-income population. The research presented will focus on successfully implementing a sustainable alternative to steel and concrete, structural bamboo, in developing countries. The technical report requires the complete design of a pedestrian footbridge. The research provided focuses on the successful implementation of a new sustainable design. The two intersect because they focus on feasible, sustainable solutions for universal needs.

The Pocona community in Bolivia requested Engineers in Action to design and construct a pedestrian footbridge. The small community of 220 people near the K'ellu Mayu River cannot cross the river safely. The isolated community must cross the river to access local markets, schools, and hospitals. The river floods 150 days of the year rendering it impossible to cross half of the year. Makeshift crossings exist but do not provide a secure solution. The design of the project is presented to university chapters to challenge students to design a footbridge while providing designs for Engineers in Action to help rural communities. The organization's structure allows students to help others in developing countries by applying the technical knowledge they have learned.

The technical report required the design and construction plan of a suspended pedestrian footbridge to be built in Pocona, Bolivia. The footbridge requires the students to determine the best geometric layout of the bridge. Once the geometric layout is decided, components are

selected and evaluated based on a rigorous calculation process. Components include the abutment of the bridge, the tower holding the cables upright, the anchor holding the cables back, and the cables. The nominal capacity is calculated (the unfactored capacity based on material properties and dimensions), and the value is then compared to a factor of safety. The calculated values must exceed the minimum factor of safety. The priority in the design of the footbridge is safety; thus, meeting every factor of safety is required. The design process is split into the standard design and the custom design. The standard design does not modify any components while the custom design does. The University of Virginia's student's standard design failed to meet the factors of safety. The custom design initially met the safety factors. A discrepancy in the calculations resulted in the bridge not satisfying the factors of safety. As a result, the students proposed raising the left anchor to pass the anchor uplift and tower overturning and extending the left abutment length.

Due to the exponential growth of the human population, the built environment has expanded dramatically. With more structures, the carbon emissions from the lifecycle of the buildings must be addressed. Environmentally sustainable solutions cannot just be applied to the developed nations, there must be a universal solution. The successful implementation of a sustainable alternative to structural steel and concrete like structural bamboo can reduce the overall carbon footprint of structures while providing developing countries with a cheaper alternative to the known structural materials. Implementing sustainable designs can help foster the pillars of sustainability: environmental, social, and economic. The research was derived from three sources: analyzing technical research to understand the practicality of structural bamboo, interviewing a current Peace Corps Volunteer in her sustainable development project, and utilizing Engineers in Action as a case study to understand why they chose to locally source materials to promote sustainable development.

Sustainable engineered development does not just provide structures with a low carbon footprint. Providing long-term maintenance and cost-effective means will ensure the long-term cost will decrease. Including the population affected by the structure in the construction process can provide some communities that lack the expertise to maintain said structures. New emerging technologies like structural bamboo can be applied in limited use. Offering structural bamboo can provide a sustainable design by providing a natural resource. Locally sourcing materials drives down the economic and carbon cost of a project. Furthermore, locally sourced materials and teaching the local affected communities will ensure the design can be installed and maintained.