

Design Improvements to Simple Wire Rope Bridges

Aaron Jacques

Lipscomb University

EXTENDED ABSTRACT

The aim of the 2007 bridge construction trip to Chicacao Guatemala was to design and construct a structure for crossing the local river that improved upon the bridge design installed downstream in the summer of 2006. The local village was in desperate need of a way to traverse the river safely and easily. The previous iteration of the suspended wire rope bridge had noticeable vibrations upon loading, a minimum amount of clearance to flood conditions, and little resistance to transverse loadings.

The project was guided by the project leader David Fann who organized the logistics of procuring materials, lodging, and relations with the local village that the bridge was to benefit. Within the guidance of the project leader, volunteers, both professors and students, were broken down into two teams; bridge design and bridge construction. An upperclassmen and professor who were intimately involved with the bridge trip of the previous year were assigned to be team leaders, giving guidance and doing the bulk of the design and planning.

The previous Guatemala bridge of 2006 was the first iteration and an excellent starting point for design. Both bridges are constructed of two concrete bases approximately 100 feet apart on either side of the river; a wire rope connects the two bases and supports the bridge decking. The bases are in the shape of a large stairway with two pedestals placed on the top landing to support the handrails. Bridge decking is a simple expanded metal grating welded onto box beams which were then securely bolted to the wire rope. The shape of both 2006 and 2007 designs were modeled by a parabola. Although a catenary is the more general contour for a suspension bridge, the parabolic contour was appropriate for the bridge span and the sag chosen for the design. The basic design and mathematical model from the 2006 design carried over as the concept behind the 2007 bridge. In 2007, to improve the freeboard between the river and the bridge, the geometry of the base increased in both height and width from the previous iteration. The width increased to prevent the tipping and sliding of the base in the direction of the river. Vibrations due to dynamic loading in the previous design caused minor difficulty in traversing the bridge, and only increased with the addition of people, a problem addressed in the 2007 design. The handrails were tensioned, placed outboard of the main load bearing cables, and connected to the walkway cable with a sliding joint. The aim was three fold; increased lateral support of the entirety of the span, bear a small percentage of the load, and provide a resistance to the vibration of the walkway.

The 2007 bridge design successfully achieved its goal of improving on the previous bridge design. The freeboard over the river improved significantly but was less than expected due to a translation error in the drawings used to construct the bases. Placing tension in the handrails justifiably improved the dynamic stability under the loading of any number of pedestrians. It was assumed that the ability of the bridge to handle transverse loads increased, although no observations of strong wind on the bridge were noted during the duration of our stay. The 2007 Guatemala bridge trip went smoothly with little problems during construction, providing a stronger, safer, and more robust bridge design.