Current structural engineering theory holds that excessive elastic deformations in structures are undesirable. Our study challenges this philosophy. We believe that, if designed appropriately, civil cable structures, such as cable-stayed and suspension bridges, cable roofs and foundation anchorage systems, made of nontraditional, flexible materials, like polyester rope, can actually benefit from large deformations. This is due to the associated nonlinear stiffening which leads to considerable overload resistance. Due to their cost-effectiveness, these polyester-rope structures would be especially beneficial in rural communities. Polyester rope is a nontraditional flexible engineering material that can be a potential alternative for steel-cable structures because of its low cost, creep rate, and weight as well as its high durability. A low creep rate ensures that tensile structural elements are not susceptible to excessive strain and/or creep rupture under sustained pre-stress. Low weight is advantageous because transportation of materials and construction equipment to rural sites is often costly and challenging. Moreover, to prevent fast material deterioration and associated out-of-service status, high material durability is crucial. Although the use of polyester rope in civil engineering applications, such as suspended bridges is rare (examples include a 13.7 m demonstration bridge at Princeton University and a recently constructed 64 m bridge in Morocco completed by Columbia University’s chapter of Engineers Without Borders, EWB), its comparable success to steel cable in applications, such as deep water mooring suggests that polyester rope can potentially replace steel cable in civil engineering cable structures. Polyester rope has a material stiffness which is low compared to that of steel-cable material. Therefore, polyester-rope structures are inherently more flexible than steel-cable structures. As a result, serviceability limit states (and not safety criteria) are more likely to govern the design methodologies. When subjected to gravity loading, this low stiffness results in large global deformations and low natural frequencies. Consequently, dynamic pedestrian comfort criteria are among critical constraints for polyester-rope suspended footbridges. We focus on other ways of modifying the dynamic response of the systems, such as increasing pre-stress and exploring alternative topologies. We were involved in the preliminary design and the testing of the polyester rope footbridge in Morocco.

PUBLICATIONS: