The Institution of Structural Engineers

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2012/13 Undergraduate Research Grant Scheme – Executive Summary

Project title:
Feasibility prototype of a floating solar tower

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Project summary:
Solar updraft tower plants are an emerging renewable energy generation technology. They consist of a circular greenhouse in the middle of which stands a tall tower. Solar radiation heats up the air in the greenhouse which drives the air up the chimney by buoyancy effect. Turbines located at the base of the chimney extract electrical energy from the air flow. It has been proven that for this system to be commercially viable, the tower needs to be extremely tall – around 1000m. Building towers of such heights using conventional materials is extremely challenging both technically and economically. This project explored the feasibility of building extremely tall towers out of fabric supported by lighter-than-air gas.

During the first phase of the project, various conceptual designs for a full scale floating fabric tower were investigated. Three main alternatives were: a free-floating stacked-tori tower, a floating tower restrained laterally by guy cables, a floating tower reinforced by vertical plastic stiffeners and compressed air rings. This phase concluded that only the free-floating design gives feasible aspect ratios and Helium volume.

In the second phase, a stacked prototype was built by gluing PVC tori. The prototype was tested statically for lateral stability and stiffness by applying lateral loads along the height of the tower and measuring the deflection along the height for varying values of the internal tori pressure. Dynamic tests were also carried out in a wind tunnel for various wind speeds and inflation pressures. The measured deflected profiles showed that depending on the inflation pressure, the tower deforms more in shear or bending. Empirical relationships between deflected shapes, wind and internal pressures were derived. The project produced a wealth of practical information that will be extremely useful to build the next 5m tall prototype.