The Institution of Structural Engineers

International HQ
11 Upper Belgrave Street
London SW1X 8BH
United Kingdom
tel: +44 (0)20 7235 4535
fax: +44 (0)20 7235 4294
mail@istructe.org
www.istructe.org

2012/13Undergraduate Research Grant Scheme

Project title: Feasibility prototype of a floating solar chinmey

University: University College London

Supervisor: Philippe Duffour

Student: tba

Aims of research:
Solar thermal chimney plants consist of a large circular green house (the collector) which is open at the perimeter
and at the centre of which stands a tall tower. Air beneath the collector is heated through the greenhouse effect. The temperature difference between the base of the tower (hot) and the top (cold) creates an updraft. A turbine, located at the base of the chimney, extracts mechanical energy from the airflow to produce electricity.

The aim of the research project is to investigate the practical feasibility of novel design of solar towers though building a small scale prototype.

Description of method:
Theoretical models of the system show that the efficiency of the plant is proportional to the height of the chimney. This indicates that the chimney should be as tall as possible – of the order of 1000m for this technology to compete with existing power supplies. This presents an obvious structural engineering challenge as such a slender structure is extremely susceptible to buckling and lateral loads. The few existing prototypes or conceptual designs of solar thermal plants used conventional structural systems such as steel or concrete shells. However there are technical and economic limitations on how high such structures can be built.
The novel concept to be investigated in this project is based on using a double skin cylindrical shell made of fabric and supported by rings of lighter-than-air gases and compressed air. As the self-weight of the tower is no longer an issue, the height of the chimney can be increased beyond conventional designs.
The research project will include:

- Finalising an existing fabric design of a scaled model of the chimney (around 1m high)
- Produce a construction method that could be scaled up to industrial size plants;
- Investigating practical construction issues through building the prototype. Of particular interest are issues surrounding the integration of the gas-filled rings within the fabric, e.g. Helium and compressed air supply to the upper rings;
- Investigating the lateral resistance and stability of the chimney through static push over experiments;
- Investigating the aerodynamic behaviour of the structure through wind tunnel testing (existing facility)
- Investigating the potential of a guyed design and test it for fabric fatigue through cyclic loading (using existing equipment).

The project will be run by a pair of third year undergraduate civil engineering students. It connects with an existing EngD in collaboration with Lindstrand Technologies Ltd, a world-leading company in the manufacture of fabric structures.

Benefits to structural engineering:
Fabric structures are currently only used for very specific applications (balloon, tents, roof canopies, temporary shelters). However the potential for tall slender structures has so far been almost untapped. A prototype would provide a tangible demonstration that they can be alternatives to conventional chimneys in many cases, especially in earthquake prone areas.

Proposed finish date: tba