Tensairity Structure with shape memory alloy wire ropes.

KEYWORDS

- ❑ TENSAIRITY
- ❑ SHAPE MEMORY ALLOY
- ❑ WIRE ROPE
- ❑ LARGE ROOFS
- ❑ AIRSHIPS
- ❑ HIGH-ALTITUDE PLATFORMS (HAPS)

AREA

- ❑ CIVIL, CONSTRUCTION & MECHANICAL ENGINEERING

CONTACTS

➢ PHONE NUMBERS
+39.06.49910888
+39.06.49910855

➢ EMAIL
u_brevetti@uniroma1.it

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Patent Type
Patent for invention.

Ownership
Sapienza University of Rome 100%.

Inventors
Walter Lacarbonara, Biagio Carboni.

Industrial & Commercial Reference
Industrial, Civil, Aerospace: long-span roofs, temporary bridges, aerostats, stratospheric platforms, space habitats.

Time to Market
Preliminary prototype realized and tested; 24 up to 36 months for the final prototype manufacturing and product ready for the market.

Availability
Licensing, Research, Development, Experimentation, Start-up and Spin-off.

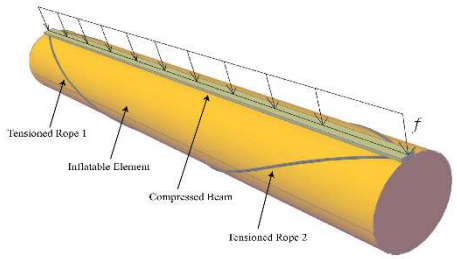


Fig. 1 Basic tensairity scheme.

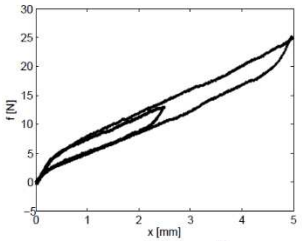
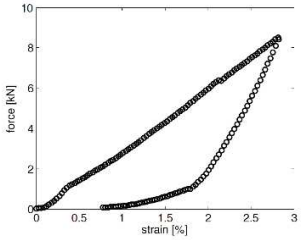


Fig. 2 hysteresis cycles of the SMA Tensairity prototype with zero residual strains at full unloading. The structural damping is greater than 200% of the classical Tensairity damping.

Fig. 3 Tensile Hysteresis cycle of a mixed joint steel-alloy cable with large structural damping and where the residual strain is due to friction.



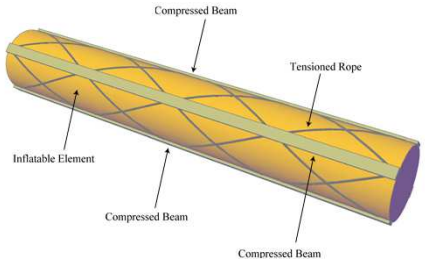


Fig. 4 Tensairity for multidirectional actions.

Abstract
The invention deals with the structural element known in the technical literature as “Tensairity” and introduces as new elements with respect to the state of the art systems of shape memory alloy (SMA) wire ropes with superelastic and shape recovery behavior together with a control apparatus which makes the structural system active.
A highly damped structure capable of sustaining dynamic loads is obtained together with the adaptability of its mechanical properties in real time according to the operational requirements.
The active SMA Tensairity turns out to be a highly performing structural system capable of resisting hard dynamic excitations while being very lightweight. Potential applications range from the civil to the industrial engineering fields. Moreover, the active features make the structure suitable for aeronautical and aerospace applications.

Publications

- ❖ Luchsinger, R. H., Pedretti, A., Steingruber, P., & Pedretti, M. (2004). The new structural concept Tensairity: Basic principles. Progress in structural engineering, mechanics and computation, 323-328.
- ❖ Luchsinger, R. H., Pedretti, M., & Reinhard, A. (2004). Pressure induced stability: from pneumatic structures to Tensairity (R). Journal of Bionics Engineering, 1(3), 141-148.

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Tensairity Structure with shape memory alloy wire ropes.

Technical Description

The basic component is a cylindrical inflatable element with a slender rod fixed longitudinally along one of its directricies.

A couple of shape memory alloy wire ropes with superelastic and/or shape recovery capabilities are wrapped around the pneumatic element and connected to the rod ends.

A control apparatus makes the structure active adapting in real time its mechanical properties to the desired requirements.
The apparatus is formed by a CPU, sensors monitoring the kinematic and mechanic conditions of the structure, an electric circuit for regulating the electric current in the wire ropes.
The latter are controlled exploiting the Joule effect. Starting from this basic configuration more complex structural geometries can be realized.

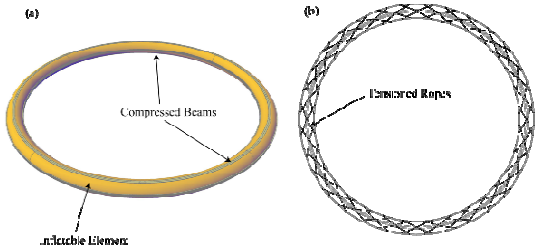

Fig. 5 Toroidal Tensairity.

Technologies & Advantages

Broadly speaking, Tensairity structures can sustain huge loads in spite of their being very lightweight.

The proposed Tensairity allows its load-bearing use in applications which feature multi-directional dynamic loads.

This advantage is enabled by the additional damping provided by the shape memory wire ropes that make also the structure active.

The geometric stiffness of the structure can be varied in real time through a processor connected to a sensors network monitoring the temperature and tension in the wire ropes as well as the Tensairity oscillations (i.e., accelerations).

In response to the processed information the control apparatus regulates the electric current in the wire ropes and the temperature and tension of the wire ropes.

Applications

The proposed Tensairity can be employed for long-span roofs subject to dynamical loads (wind gusts) as, for example, in buildings of historical and monumental interest which are generally subject to structural constraints. Such Tensairity structures can be employed to realize temporary bridges capable of sustaining vehicles which induce dynamic effects.

In aerospace applications, the basic Tensairity structure can be developed for more complex (variable) geometries for realizing airships which operate as stratospheric platforms.

The capacity to resist dynamic loads combined with their being lightweight makes the invention particularly convenient for manufacturing high performance airships mainly in terms of payload and flight time.

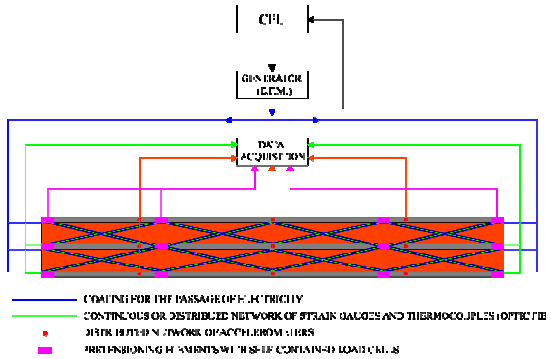

Fig. 6 Schematic control of theTensairity.

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