AN EXPERIMENTAL STUDY ON BEHAVIOUR OF TENSAILITY BEAM SUBJECTED TO VERTICAL LOAD IN COMPARISON WITH RCC BEAM

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Introduction:

Tensaility is a lightweight structural concept, a synergistic combination of an air-beam, cables and struts, which is categorized as a pneumatic structure. The central idea of Tensaility is to use a low pressure of the internal air to stabilize compression elements against buckling. The unique combination of flexibility and stiffness, of weakness and strength in Tensaility leads to a multitude of interesting properties. Tensaility beams offer an economical solution for members subjected to loads due to the current increasing price of steel and the advantages offered during the construction process.

In its most basic form, a Tensaility beam consists of simple air beam (a cylindrical membrane filled with pressurized air), a compression element tightly connected to the air beam, and two cables running (wrapped) in a helical form around the air beam. The central idea of Tensaility is to use low pressure air to stabilize compression elements against buckling. Cables under tension are the most efficient way of structural use, since the cable strength is independent of the length of the cable and solely given by the material strength. Constructive separation of tension and compression is a major goal of good light weight engineering. The result is a modified air beam with the same load bearing capacity as a steel beam but with a dramatically reduced weight.
Objectives:

The objectives of this study are as follows:
1. To conduct an experimental study to understand the behaviour of Tensairity beam subjected to vertical load.
2. To study the material properties used for a Tensairity beam.
3. To analyse and design the behavior of a simply supported Tensairity beam.
4. To find out the comparison between a Tensairity beam and RCC beam due to the method used and factors influencing the designing.
5. To verify the proposed design by comparison with those developed by other researchers and codal provisions.

Methodology:

This study is more focused on analyzing and designing a spindle shaped Tensairity beam. The result of analyzing and designing this type of Tensairity beam has been compared with a RCC beam to know its flexural behavior. One of the rational reasons, this study has been conducted is to determine the method and formula used in designing a Tensairity beam. With the information at hand, standard method and formula to design the Tensairity beam could be used and more extensive researches could be planned for the future.

The following procedure was adopted for conducting the test:

1) Concrete beams of size 700 x 150 x 150 mm had been used for this study to test its flexural strength subjecting them to two point loading test. A total number of 3 specimens were casted for same proportions. These beams were tested for flexural strength in Loading Frame Machine of capacity 50 tones in BMT laboratory, DSCE, Kumaraswamy Layout, Bangalore. 2 nos of 12 mm diameter bars were used for flexural reinforcement at bottom and 2 nos of 10 mm diameter bars were provided as a compressive reinforcement. For each beam, 2 legged 8mm diameter mild steel bars were used as stirrups spaced 100 mm c/c against shear. All beams were cast by using M20 grade concrete with 20 mm size of coarse aggregate, locally available sand and OPC 53 grade cement.

2) The PVC Coated Nylon Fabric of 1m length and 21.4cm diameter with span to depth ratio equal to 4.67 was made into a spindle shaped membrane filled with compressed air with an internal pressure 3.62 psi making it a very light and deployable beam to test under the same conditions as of RCC beam to compare its flexural behavior. The simple air-beam was spiraled by a cable that acts as a backbone to hold it all together.

Fig 2: Testing of RCC beam and Tensairity beam under loading frame
Results and Conclusions:
1) The goal of structural engineering often structures is to find an optimal balance between tension and compression. This balance could be optimized with Tensairity.
2) The fabric plays an important role in Tensairity. It is pretensioned due to compressed air. Hence it can transfer compressive forces from the upper chord to the lower chord. The fabric stabilizes the chord under compression against buckling. Also the fabric has to take care of the shear forces. The fabric used was PVC coated Nylon Fabric, which is the key to the outstanding properties of Tensairity such as light weight, fast, and simple set up, compact transport and storage volume, interesting lighting options and so on.
3) The deformation of a Tensairity girder for a given load can be varied simply by changing the air pressure of the structure.
4) The ultimate load bearing capacity of RCC beam was found to be 29% more than that of a Tensairity beam.
5) The deflection of Tensairity beam was found to be 84% higher than that of a RCC beam until failure. However Tensairity structures do not show brittle behavior. They do not collapse suddenly without warning. In case of overloading, deflections become large and therefore clearly visible. There should be enough time to react promptly and properly.
6) Tensairity beams are almost 9 times lighter than RCC beams.
7) Though RCC continues to be a dominant construction material, Tensairity concept is limited to deployable light weight temporary structures.
8) Finally, experiments on Tensairity beams have regularly shown failure modes caused by buckling of the compression element. Apparently the support provided by the air tube is not sufficient in these cases. For practical applications this implies an increase of the cross-sectional dimensions of the strut.

Scope For Future Work:
Tensairity beam can be analyzed for the following:
1) Different shapes and dimensions
2) Variation in thickness
3) Finite element analysis using software
4) Variation in internal pressure due to the compressed air
5) Variation in the types used and geometrics of tensioning cables and compression struts