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STRUCTURAL LOAD CONTROL DURING CONSTRUCTION

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In the absence gravitational pull, the major design considerations for large space structures are stiffness for controllability, and transient dynamic loadings (as opposed to the traditional static load associated with earth-based structures). Because of the absence of gravitational loading, space structures can be designed to be significantly lighter than their counterparts on Earth. For example, the Space Shuttle manipulator arm is capable of moving and positioning a 60,000 lb payload, yet weighs less than 1,000 lbs. A recent design for the Space Station which had a total weight of about 500,000 lbs. used a primary load-carrying keel beam which weighed less than 10,000 lbs. For many large space structures designs it is quite common for the load-carrying structure to have a mass fraction on the order of one or two percent of the total spacecraft mass. This significant weight reduction for large space structures is commonly accompanied by very low natural frequencies. These low frequencies cause an unprecedented level of operational complexity for mission applications which require a high level of positioning and control accuracy. This control problem is currently the subject of considerable research directed towards reducing

the flexibility problem. In addition, however, the small mass fraction typically results in structures which are quite unforgiving to inadvertent high loadings. In other words, the structures are "fragile."

In order to deal with the fragility issue CSC has developed a load-limiting concept for space truss structures. This concept is aimed at limiting the levels of load which can occur in a large space structure during the construction process as well as during subsequent operations. Currently, the approach for dealing with large loadings is to make the structure larger. The impact this has on construction is significant. The larger structures are more difficult to package in the launch vehicle, and in fact in some instances the concept must be changed from a deployable truss to an erectable truss to permit packaging. The new load-limiting concept is aimed at permitting the use in large space structures of smaller trusses with a high level of strength robustness, in order to simplify the construction process. To date several analyses conducted on the concept have demonstrated its feasibility, and an experiment is currently being designed to demonstrate its operation.

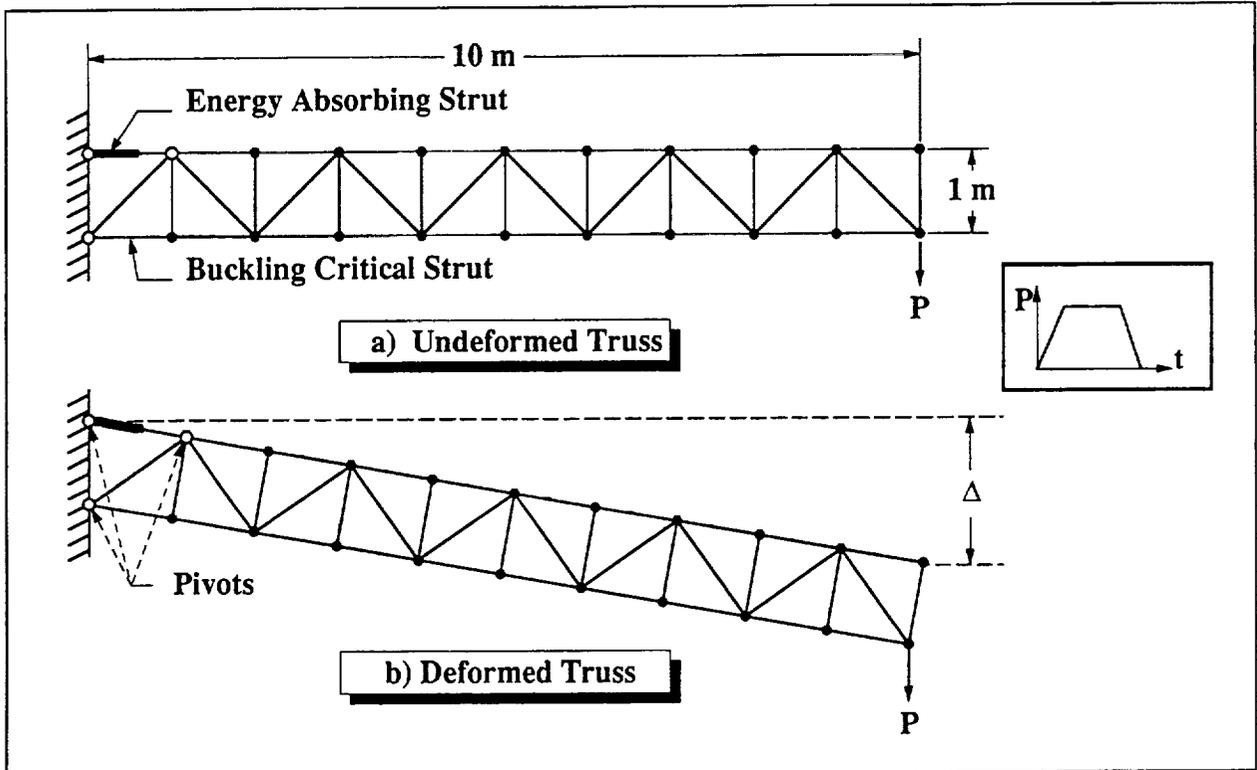


Fig 5.1 Example of a ten-bay long fail-safe truss

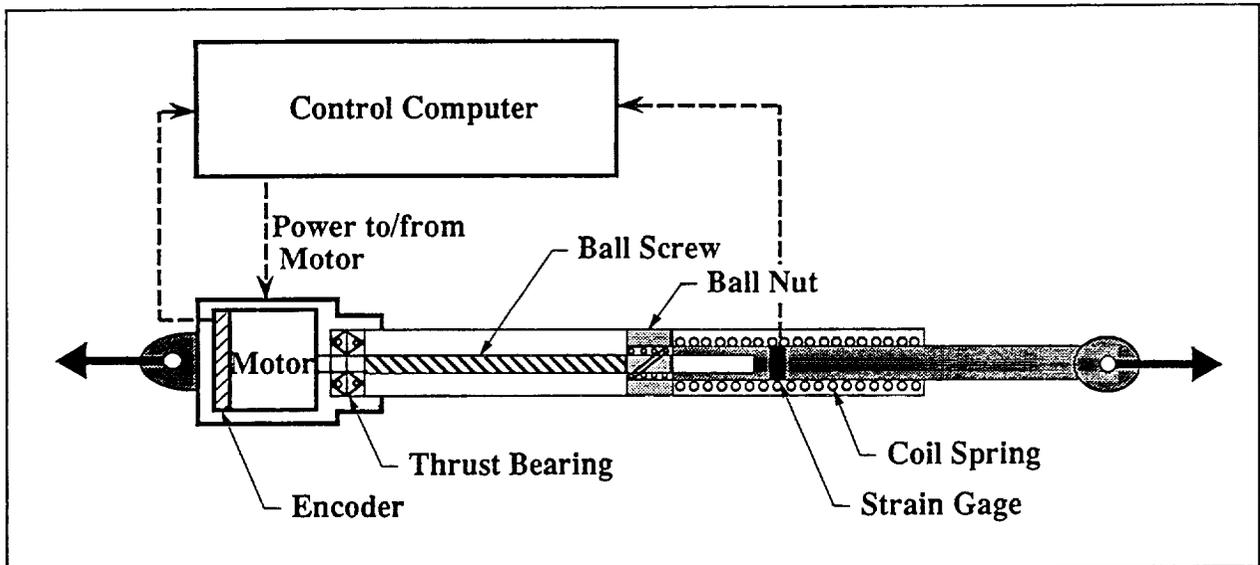


Fig 5.2 Linear load and motion control actuator (energy absorbing strut)

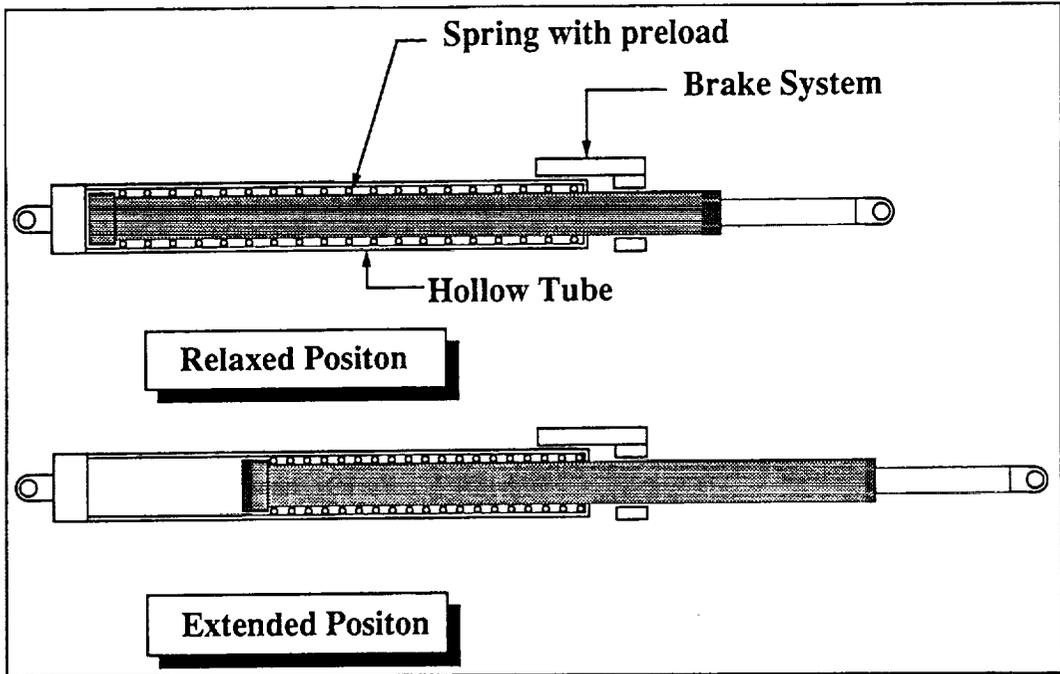


Fig 5.3 Schematics of energy-absorbing strut

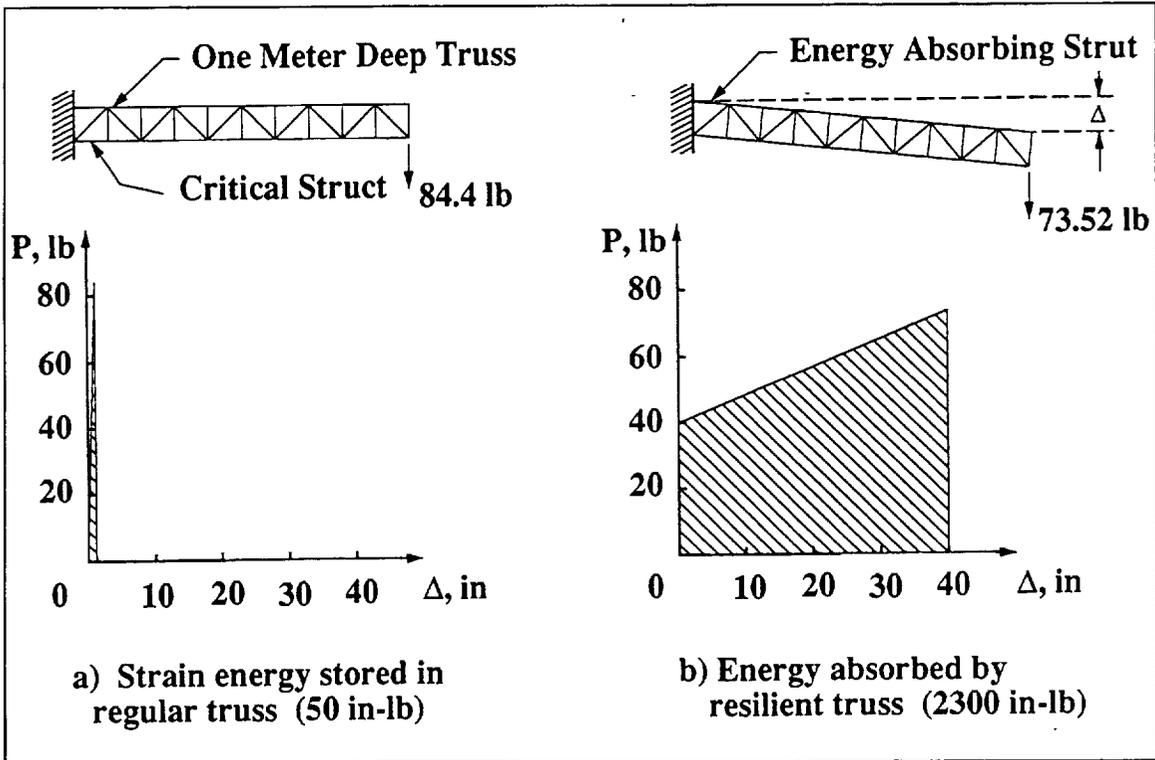


Fig 5.4 Stored energy characteristics of one-meter deep truss