Abstract

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A new approach for measuring force and stroke margins for Frangibolt actuators has been developed and is described in this paper. Frangibolt actuators, which are sold by Ensign-Bickford Aerospace & Defense Company (EBAD), are widely used across the Aerospace industry as hold-down and release mechanisms (HDRMs). They use a resistance heater to warm a piece of shape memory alloy (SMA), which grows in length enough to break a notched fastener, thereby releasing the bolted joint. The SunRISE project uses FD04 Frangibolt actuators to release deployable antennas. The SMA alloy in this line of actuators is formed from a single crystal of Copper, Nickel, and Aluminum. This particular alloy exhibits a greater expansion than the more traditional FC series of multi-crystal Titanium-Nickel alloy. In our initial exploratory testing with the FD04, we followed the same testing approach others have used to test FC series Frangibolt actuators, but the behavior was sufficiently different that we consulted with EBAD. As a result of that discussion, we understood that the test procedure used on the FC series Frangibolt was not applicable to the FD04, and that led us to develop a new testing methodology. The novelty of this test procedure is that an initial pre-load is applied to the Frangibolt which simulates the load a torqued bolt in a flight assembly would apply. Due the difference in nature of the crystals in the SMA, this pre-load application was not needed for the FC Frangibolt series. After the pre-load is applied, our FD04 Frangibolt is actuated, and the load it experiences linearly increases to the desired test load. The stroke of the Frangibolt was measured at each test load using an extensometer. The force and stroke needed to break the bolt are 2860 N and 0.201 mm, respectively, which were calculated from data provided by EBAD. In this paper, we explain the novel features of our test method and the nuanced differences between our method and that which was used for the FC Frangibolt series. Details of our test results are also provided which ultimately verify that the FD04 Frangibolt demonstrates more than enough force and stroke to break the notched Frangibolt fastener: 5720 N and 0.490 mm, respectively.