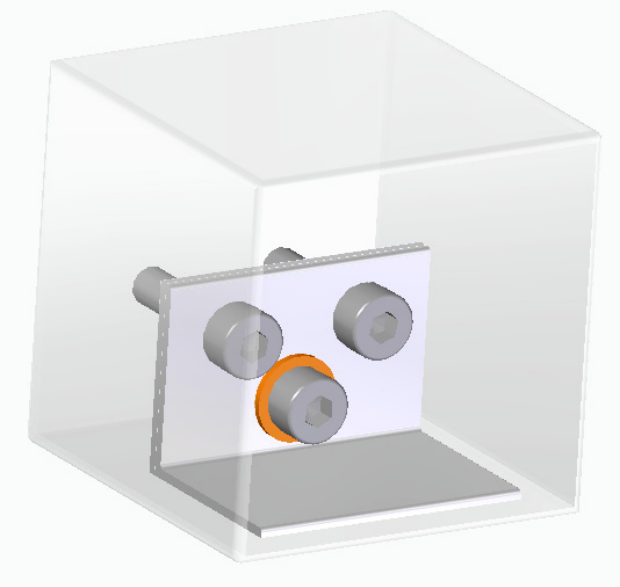
The effects of low temperature on bolts adjustment (from IFF 362)



APPLICATION FOR SPACEFLIGHT

Cubes in Space Research Balloon 6 - 2020

ABOUT US

The school

The San Felipe Neri Institute is a school located in the city of Buenos Aires, Argentina. For over fifty years, the institution has been devoted to educating Argentine youths in all their levels of education: Kindergarden, Elementary, Middle and High school. Instituto San Felipe Neri has been a pioneer in the incorporation of cutting-edge pedagogical methods, currently incorporating numerous technological resources for the development of STEM subjects.

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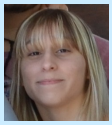

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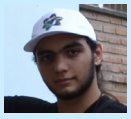

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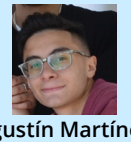

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The effects of low temperature on bolts adjustment

Hypothesis

If the temperature of the natural space environment is very low, bolts loosen up as the result of the contraction of the material.

The independent variable is the low-temperature that exists in the natural space environment, and the dependent variable is the degree of adjustment of the bolts.

Experiment Purpose

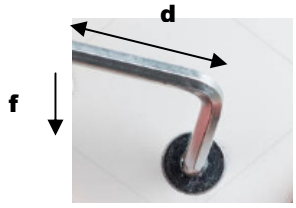
We propose to design a structure that supports at least two different kinds of bolts and nuts, with the intention of joining two panels with the same adjustment force (torque) to determine the variation in the adjustment of such bolts, as a direct consequence of the low-temperature environment it will be exposed to on the balloon journey.

In the high atmosphere, the conditions of low-temps are extreme (about -50ºC). Under these conditions, the metal structures contract and may loosen up all junctures. Our intention is to measure the degree of adjustment of the bolts and compare them with similar structures based on Earth.

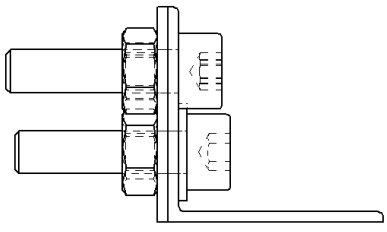
Experiment Description

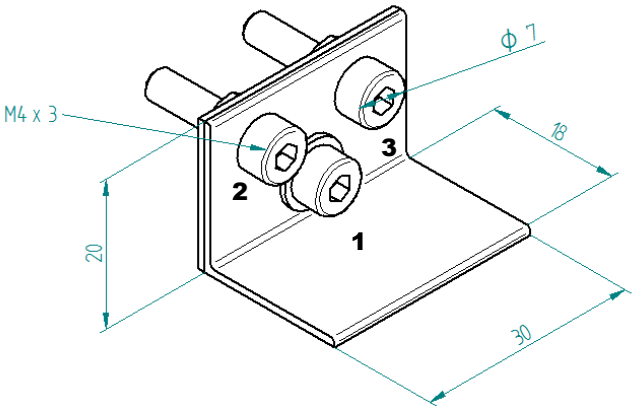
From a 1060 aluminum profile, in which we will make three holes that will serve as a support for the screwed joints, we will hold three screws: two of them will be adjusted with different torque and the remaining one fastened with a synthetic material washer. The design of the experiment requires knowing the degree of fit of the joint as precisely as possible. To do this, the screw heads will be of the "allen" type to be able to insert a wrench with a lever arm of known length. Using the momentum equilibrium equation of a force:

$$M = f.d$$

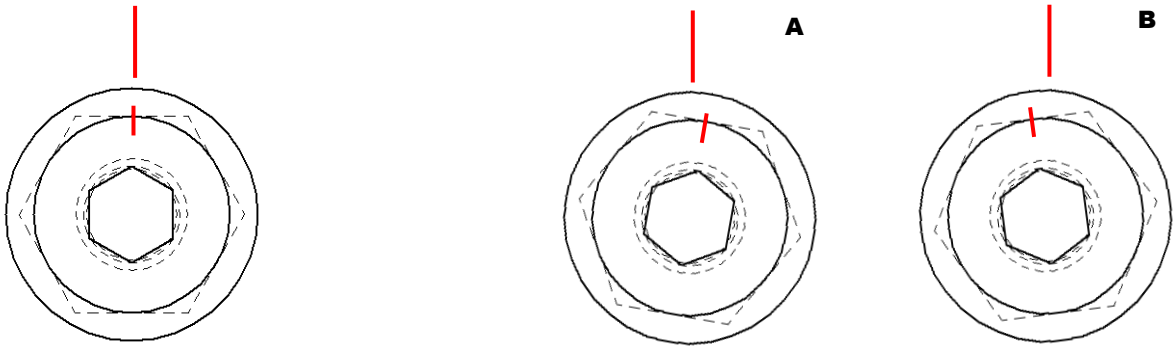


M being the torque, f the force and d the distance from the end of the lever to the center of the screw, we can know the magnitude of the torque. The force can be measured with a digital dynamometer or with a calibrated spring, measuring its deformation. Then we will make a mark on the screw and on the support, to compare it at the end of the experiment.





To limit the adjustment variables, the nut on the back of the support will be glued with epoxy glue.
Two identical experiments will be carried out, one of the flight and the other of control, to be tested on the ground.
Once adjusted, the joint will be tested under a low temperature prior to the flight.
After testing, we will be able to visually measure the variation in torque and measure again the necessary torque to loosen the joint.



Pre-flight configuration **Post-flight configuration: adjust (A) or loosen (B)**

The **estimated weight** of the experiment will be 30 grams.

Pre-Launch Experiment Materials

Experiment:

- An aluminum profile of size 20 x 20 x 30 mm, 2 mm thickness.
- An aluminum profile of size 20 x 20, 2 mm thickness
- Three M4 DIN 912 screws 0.7 16 mm
- Three 1 mm M4 nuts
- A M4 synthetic material washer
- Epoxy glue
- Double-sided adhesive tape

Tools:

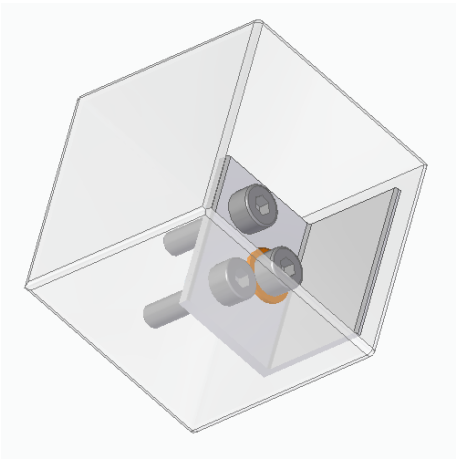
- Allen wrench M4
- Digital dynamometer
- Marker

Pre-Launch Experiment Directions

1. Joint both aluminum profiles (structure), matching the holes.
2. Insert screw 1, with the synthetic material washer, and adjust with a torque value of 0.5 Nm: 5 cm x 1 Kgf.
3. Make a calibration mark on the screw head and on the bracket.
4. Insert screw 2 and adjust with a torque value of 0.5 Nm: 5 cm x 1 Kgf.
5. Make a calibration mark on the screw head and on the bracket.
6. Insert screw 3 and adjust with a torque value of 1 Nm: 5 cm x 2 Kgf.
7. Make a calibration mark on the screw head and on the bracket.
8. Store the experiment in the transport box.

Integration procedures

1. Remove the experiment from its packaging.
2. Attach the bracket base to an inner side wall of the cube with the double-sided tape.
3. Close the box.



De-integration procedures

1. Open the cube.
2. Take some pictures in different angles.
3. Peel off the base of the support from the bottom of the hub using a tool that acts only on the base of the support, taking care not to touch the screws.
4. Place in the transport box.

Post-Launch Experiment Directions

1. Perform a visual inspection of the components, verifying their integrity.
2. In the case of checking discrepancies between the marks, proceed as follows:
3. For screw 3, measure the angle between the mark on the bracket and the mark on the screw head.
4. Measure the screw loosening torque.
5. In the case of not noticing discrepancies between the marks, only measure the screw mismatch torque.
6. Repeat the procedure for screws 2 and 1.

Analysis Plan

We need to study these contractions in order to improve the torque of space structures, as well as of other structures on Earth. In order to perform such tests a special installation is required on Earth, but on board a scientific balloon, the temperatures needed for the tests are effectively obtained.
We assume that there may be other variables that can affect the degree of fit of the screws, but we estimate that the contraction and expansion of the material of the bolted joints will affect the final fit.

Communication Plan

Once the experiment is finished, we will have an approximation of what is the effect of the temperature of outer space on three types of joints subjected to -50º, with the same diameter, varying only the torque adjustment and the intermediate material (washer).

We work in coordination with the Aerospace Technology Group, dependent on the National Technological University, which provide us with advice and facilities.
All the work done is being documented from the beginning. In addition to the photographic record of each student, a collaborative blog and an informative video, we will prepare a final document to be presented to the educational authorities of the school and the University.
We also hope to be able to hold talks at educational establishments in Buenos Aires, relating our experience to inspire other students to participate in CiS 2021.

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