

## Experiments on Central Cross Protection with Candu1 Mod

UFO Doctor, Oct, 1<sup>st</sup>, 2011, rev. Oct, 2<sup>nd</sup>, 2011

### 1. Introduction

The central cross of the ARDrone needs to be very stiff, but will break at hard landings. Candu1 designed a brilliant easy protection method: plastic 4.5 mm cable ties mounted at each foot. With an additional weight of only 5 grams the impact forces at hard landings will be reduced by a factor of 2!

### 2. Material

Cable ties were mounted according to Candu1 at the feet the ARDrone (Fig.1.)

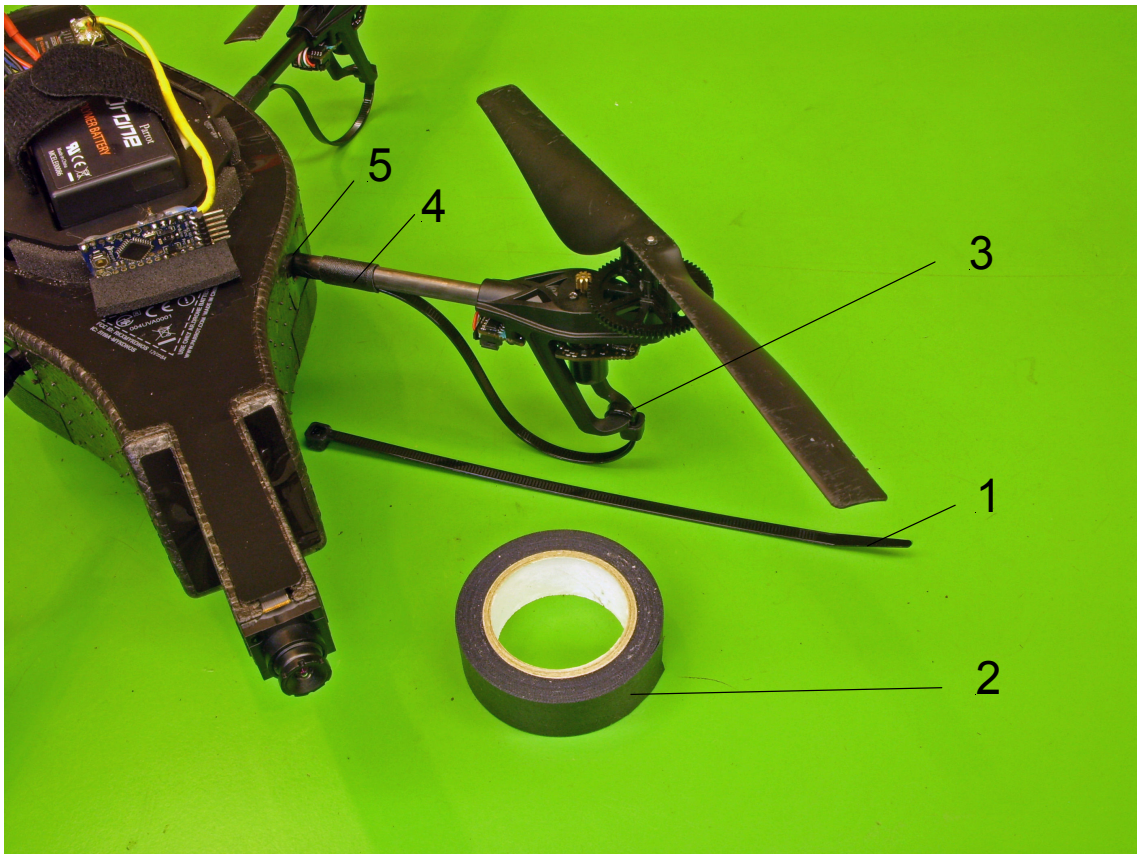


Fig. 1. Shock protection proposed by Candu1:

1: Cable tie; 2: Strong adhesive tape; 3: File front foot flat before tighten cable tie!  
4: Adhesive tape 18x40mm; 5: Only 20 mm of the tie inserted into the hull.

Material under test:

Nr.1: No protection. this is the reference

Nr.2: Cable ties 7.50 x 1.91 x 230mm, weight 15 grams for 4 units

Nr.3: Cable ties 4.50 x 1.57 x 200mm, weight 5.5 grams for 4 units

Nr.4: Cable ties 4.46 x 1.34 x 200mm, weight 5 grams for 4 units

### 3. Test method

The ARDrone was stepwise compressed from 0 to 30 mm and the generated force was measured with a bathroom scale (Fig. 2.)

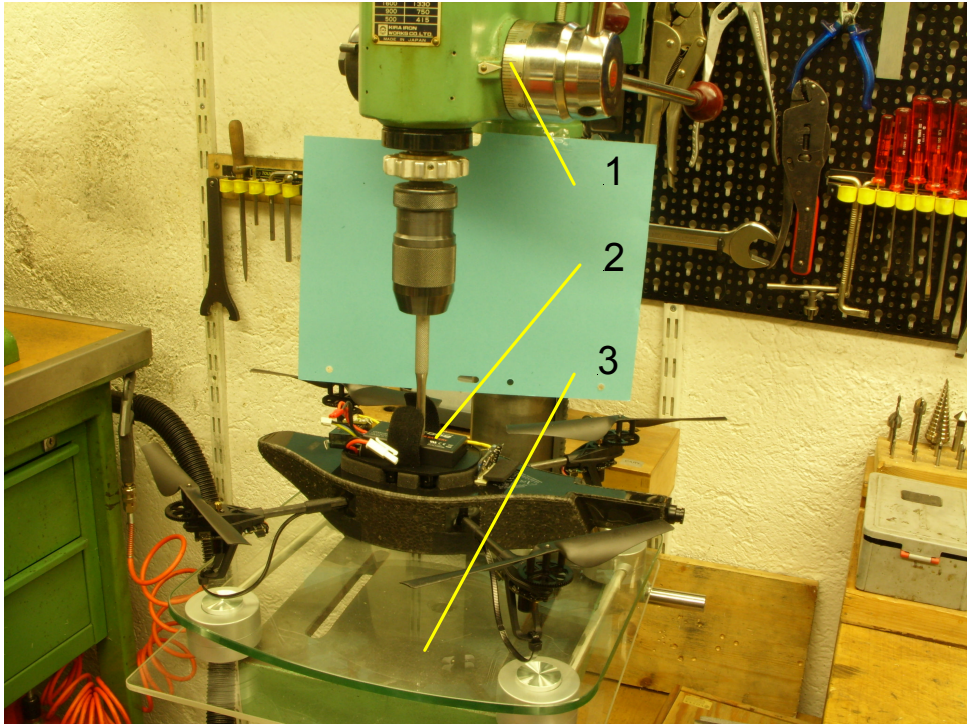


Fig. 2. Test setup  
 1: 0 to 30 mm pressed by drill press; 2: Lipo in basket; 3: Bathroom scale

**4. Experimental Results**

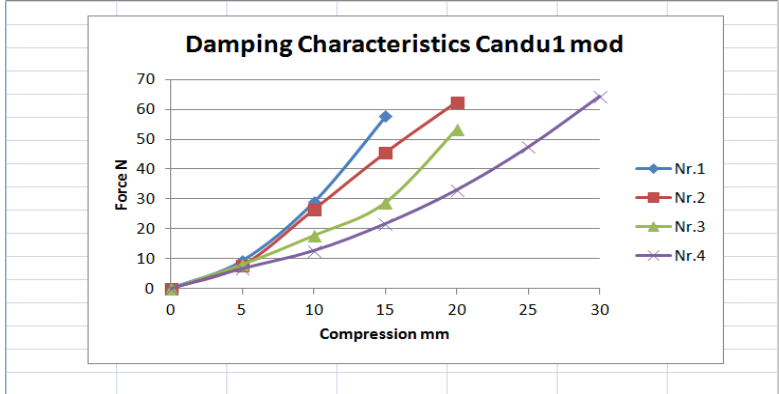


Fig. 3. Experimental Data:  
 Force versus Compression

- Nr.1: No protection
- Nr.2: Cable ties 7.50 x 1.91
- Nr.3: Cable ties 4.50 x 1.57
- Nr.4: Cable ties 4.46 x 1.34

**5. Discussion**

The theory on shock absorber is a complicated subject. But in general you have to explore the maximum permissible impact force (in our case 60 N without damage) and you should design the compression range of your mod as large as possible. In our case the 4 cable ties 4.46 x1.34 mm offer an additional elastic compression of 15 mm at a force of 60N.

Let us assume that the total mass of the ARDrone with Miru mod is a concentrated mass of 416 gram, tackle to the damping system:

You may now come back to earth on hard concrete with 2.2m/sec vertical speed, if you land on all of your four feet! Perhaps you may land faster without damage (at your own risk!), please give me a feedback!

Kind regards and enjoys the flights with the now well protected ARDrone!  
 UFO Doctor

## 5. Appendix: Experimental results, please be careful!

Here you will see the deformation of the Nr.4 cable tie under load from 0 to 35mm compression! Please be careful, you might kill the central cross of your drone!

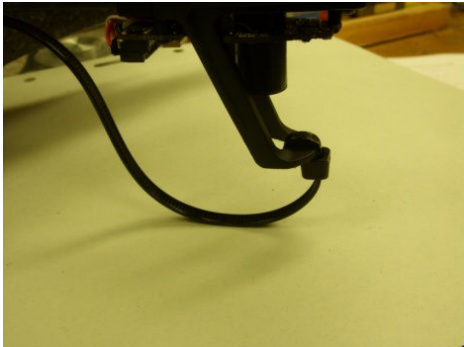


Fig.4a: No load, 0 N



Fig.4b : Compression 5 mm, 6.7N

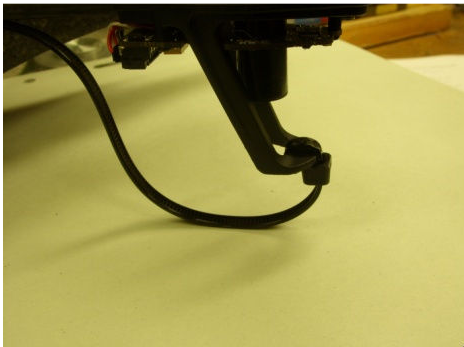


Fig.4c : Compression 10 mm, 12.7N



Fig.4d : Compression 15 mm, 21.7N



Fig.4e: Compression 20 mm, 33N

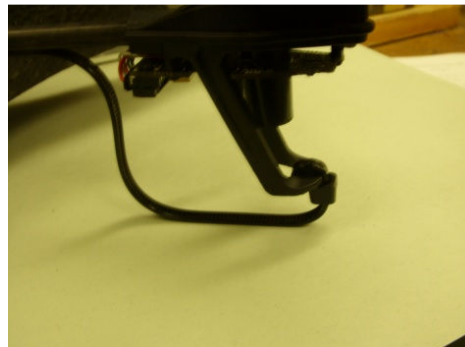


Fig.4f: Compression 25 mm, 47.3N



Fig.4g: Compression 30mm, 64.3N

Sorry, the damping system lost here the elasticity characteristics.

Please do not apply forces  $> 65$  N to your ARDrone!

The central cross or the EPP housing might be damaged!

Fig.4h: Compression 35 mm: problem!