# Reinforcement method for PVC motor casings

Reaching the next level.

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I will appreciate very much if you feed me back with your comments and experience.

Special thanks to Richard Nakka
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# REINFORCING PVC TUBES FOR SOLID ROCKET MOTORS

**IMPORTANT**
The author of this document cannot assume any responsibility for the use readers make of the information presented.

## Background

The design pressure is often limited by the maximum hoop stress that a tube can resist, then, the idea of reinforcing the tube consist on taking into advantage that the maximum longitudinal stress resisted is twice the hoop.

| | |
|---|---|
| *Pt* | Hoop design pressure |
| *Pl* | Longitudinal design pressure |
| *t* | Wall thickness |
| *fty* | Yield strength of the material |
| *Do* | Outside diameter |
| *S* | Design safety factor |

$$(1)\vdots Pt = \frac{(2.t.fty)}{Do.S} \qquad (2)\vdots Pl = \frac{(4.t.fty)}{Do.S} \qquad \therefore \qquad (3)\vdots Pl = 2.Pt$$

You can also determine the design pressure using *Casing.xls* from http://www.nakka-rocketry.net/

## Reinforcing the tube

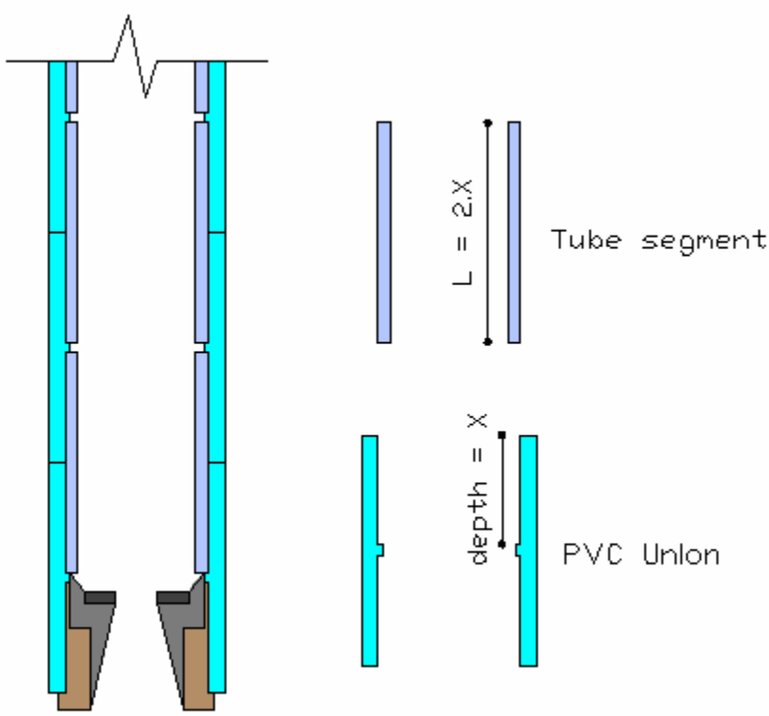
The objective is to increase the wall thickness (*t*) in the equation (*1*), by joining small segments of tubes of a longitude of twice the depth of a *PVC Union*, in order to almost double the design pressure of the casing; nevertheless, the design pressure will be the least from hoop design pressure and longitudinal design pressure.

*Recommendations*

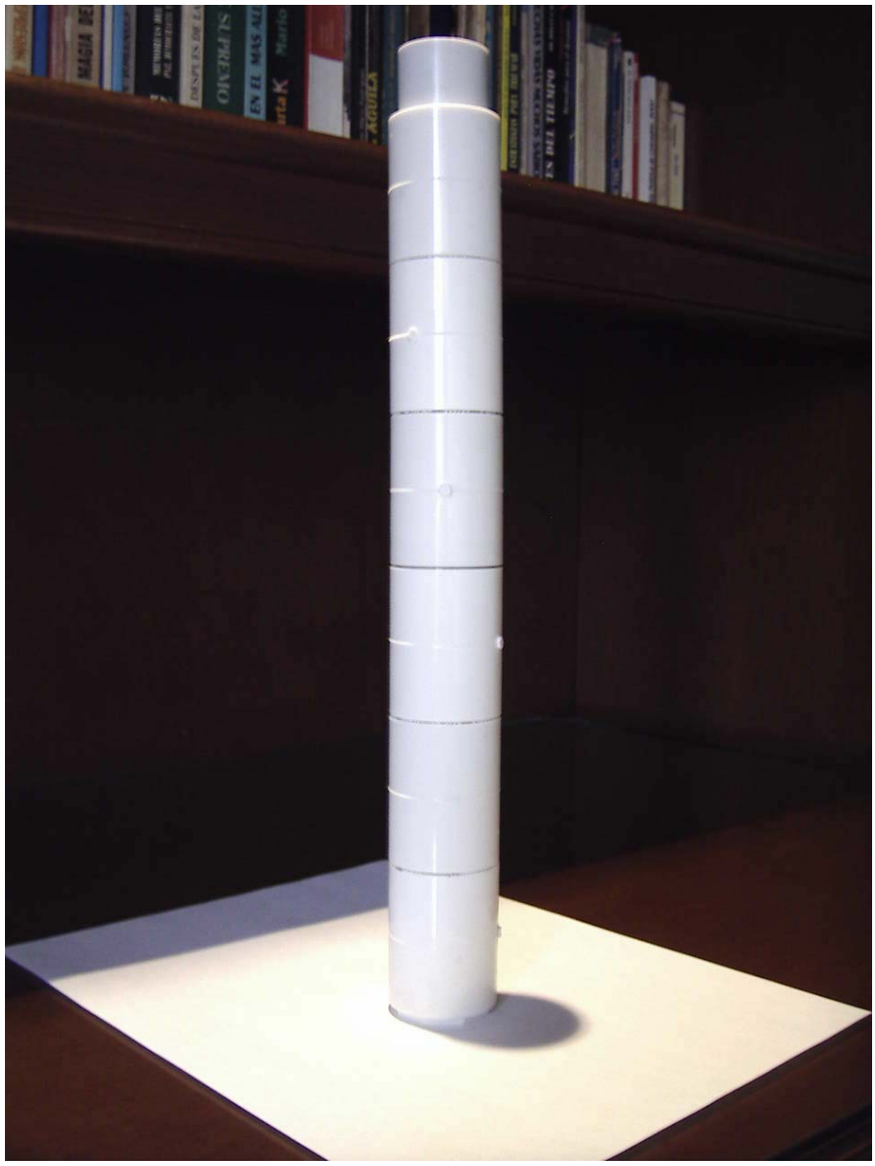
- The Tube segment must be absolutely hidden by the *PVC Unions*. This will ensure that the wall thickness (*t*) is absolutely reinforced.
- The Tube segment must reach the depth top of the *PVC Union*. This will ensure an appropriate soldering between the Union and the Tube.
- It is recommended to analyze the allowable pressure considering the outer diameter, *Do*, to be the outer diameter of the *PVC Union*, and not going on *thick-wall cylinder* calculations. This will ensure a conservative result.
- In case that the motor has an end cap, it is recommended to isolate its inner surface from fire using water putty or Portland cement.

*Considerations*

- The thickness used for calculations can be $t = t_{tube} + t_{union}$ ever since the strain of the reinforced casing would likely be pretty uniform and as a result, the full thickness would be effective.
- The wall thickness for the longitudinal design pressure calculation must be the least from $t_{tube}$ and $t_{union}$, no matter if it is reinforced, because *PVC Unions* are not soldered by their ends.

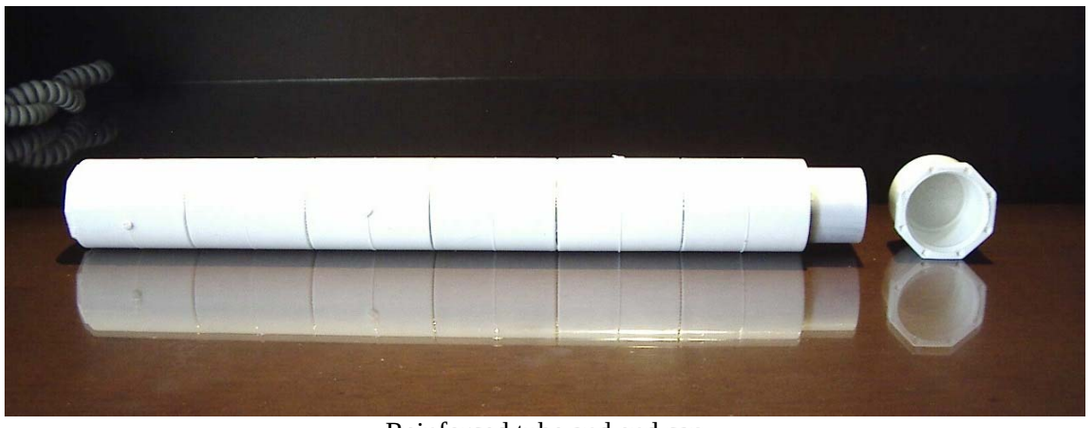


**Some photographs of the finished product**



Reinforced tube

Isolated end cap



Reinforced tube and end cap