

# Minimizing Weight Gain While Maximizing Strength When Gluing Balsa

Contributed by:

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Warning, LONG dissertation on how to minimize weight gain while maximizing strength when gluing balsa. But, it's MUCH harder to explain in writing than to actually do in practice. Plus, I'm an engineer, not a teacher.

## CA - CyanoAcrylate or super glue

**Ambroid/acetone - Ambroid, like Testor or Siment** is just one of several brands of balsa cement. Balsa cement is a solvent based glue which used to have a base of cellulose nitrate (I think) dissolved in mixtures of acetone, toluene, and other nasty things from which came glue sniffing and the term dope. The added acetone just makes it a little thinner/runnier than what comes from the tube. Good glue, but ventilation is recommended.

## Comments on glue vs. weight and strength.

- Used properly, BOTH glues are much stronger than the base wood they are connecting.
- Used properly, both glues should be contributing VERY little weight to your structures.
- Bulk CA is stronger than bulk balsa cement, but also more brittle. BUT, NO glue should be used in bulk for minimum weight vs. strength in SO structures.
- Balsa cement has a sometimes important advantage over CA, you can undo a joint with a little solvent. For all practical purposes, CA joints are PERMANENT (the stuff you can buy to decompose it is REALLY nasty, even compared to acetone).

## So, how do you use glues properly?

- It starts with joint design and execution.
  - Gluing end grain to anything is bad design, always try for side grain to side grain.
  - Joint strength is a function of the AREA being joined, so make that area as big as needed, but NO bigger.
  - ANY noticeable gap between the two surfaces being joined is bad execution. In my college days one experiment we did compared joint strength (NOT glue strength) vs. gap size. The result was strongly NON-linear and the strength was inverse to the gap until VERY small gaps (less than the glue molecule size) were reached. In fact, the peak joint strength was STRONGER than the bulk glue strength. Now, balsa is porous so you can't make joints tighter than the glue molecule size, so make joints as TIGHT as you can

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- The next key is application of the glue itself.
  - FOR CA, the biggest sin most students commit is to apply glue directly from the bottle. This is where its reputation of excessive weight comes from. Using the bottle it is impossible to apply less than a full drop, and even a small drop is WAY too much for most joints in SO structures. Here's what to do instead:
    - Make a precision micro glue applicator. Sounds complicated, but its not. Take a scrap stick of basswood or spruce about 6-8 inches long and about 1/4 by 3/8 inch cross section. Drive two pins through one end about 3/8 inch apart angled so the points just touch at their tips. That's it. (See: <http://www.gryffinaero.com/models/ffpages/tips/cyaapp.html> for photo)
    - Before you start gluing, lay out the parts in the configuration needed on wax paper on a building board. Use pins to keep them from moving, but pin next to, not through you parts. Don't put the pins too close to the joints.
    - Make a small puddle of a few drops of CA (this should be the thin stuff, not gap filling CA, remember, good joints don't have a gap) in some convenient spot on the wax paper where you WON'T accidentally stick your hand (or anything else) and glue yourself to the building board (don't ask me how I learned this).
    - Take the glue applicator, stick just the tip of the pins into the puddle and draw a small amount between the pins by capillary action. The amount can be controlled by the separation of the points and the size of the pins.
    - Transfer this small amount of glue to the joint by touching the side of the pins to the joint, capillary action of the tighter glue joint will draw the glue off the pins and into the joint. Note, a little CA goes a LONG way. Only one VERY small application is needed for most joints in Wright Stuff which have an area of about 1/16 by 1/8 inch. Do all the joints you have set up.
    - If not in a hurry, leave the joints to set naturally, if the air is dry (moisture acts as a catalyst for CA) this could actually take an hour or longer. But, the joints will be a little stronger then the following alternative.
    - If in a hurry, get some CA accelerator from the same hobby shop you bought the CA. Don't use the too convenient spray nozzle, gets the stuff everywhere and will probably contaminate your CA bottle ruining the whole thing. Instead, use a plastic dropper, and apply VERY small drops to each joint. This will set the glue INSTANTLY.
    - Now's the slightly tricky part, separating the assembly from the wax paper it's now partially glued to. First remove all the pins. Then, gently pry up each joint from the paper until the whole structure is free. This can be aided by taking an x-acto blade from its holder, laying it flat on the wax paper and gently sliding it between the structure and the paper to break free the joints.
    - DONE PROPERLY, you should have no appreciable weight gain on something like an SO wing. This means for typically 14 joints the

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weight gain is less than a couple of hundredths of a gram! That translates to only a few milligrams of glue per JOINT! These numbers come from coaching MANY students, including new ones, over the past 5 years or so. Oh, your students DO build with scales reading to .01 grams next to them and keep data don't they?

- o FOR BALSALAMITE, the application techniques are different and good joint execution (NO gaps, CA can bridge small gaps but adds weight fast when it does) is critical.
  - For light joints, its best to thin the glue as it comes from the tube about 50-50 with acetone or dope thinner. Keep it in a bottle with a very small hypodermic like tip (this doesn't work for CA as it set in the tip clogging it) so your students can apply small amounts.
  - After the joints are prepared, apply a small amount of glue to the mating surfaces, then wipe away the rest and allow to dry. This is called double gluing, and significantly increases glue strength without adding appreciable weight.
  - Next, use a wax paper covered building board again and pin down "half" (for an SO wing this would be the long spars, for a bridge, it might be the long members) the parts so they won't move.
  - Now apply glue SPARINGLY to the other parts (the ribs in a wing, or the cross members in a bridge) and join them to the parts already pinned down, pinning these new parts in place to prevent movement until dry, at least an hour.
  - Just as with the CA, now carefully separate the dried structure from the building board, use the same techniques, but it will not be glued as hard typically.
  - Just as with the CA (again from experience) your weight gain from the joints will be in the milligram per joint range on an SO wing and should be similar in bridges and towers.

Now, you will hear passionate arguments that Balsa cement is lighter than CA and strong enough for these structures. From my experience this is true, but IRRELEVANT if both are used correctly.

- Remember, with good joints the failure will always be in the base wood, not the glue, so glue strength isn't important.
- The total contribution of glue to the mass of these structures should be LESS than 5%!!! The difference between CA and balsa cement is probably less than 1-2% of the total weight of these structures. At only a few very competitive state contests and the nationals will that be important!

CA does have one BIG advantage which drove me to use it when coaching SO students. IT'S FASTER WHEN USED WITH ACCELERATOR! The parts are done NOW, where balsa cement really should dry 24 hours to reach maximum strength. I now only use balsa cement when I may need joints that can be adjusted (there are a couple on an SO plane).

Hope that provides some help, feel free to ask where I wasn't clear.

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