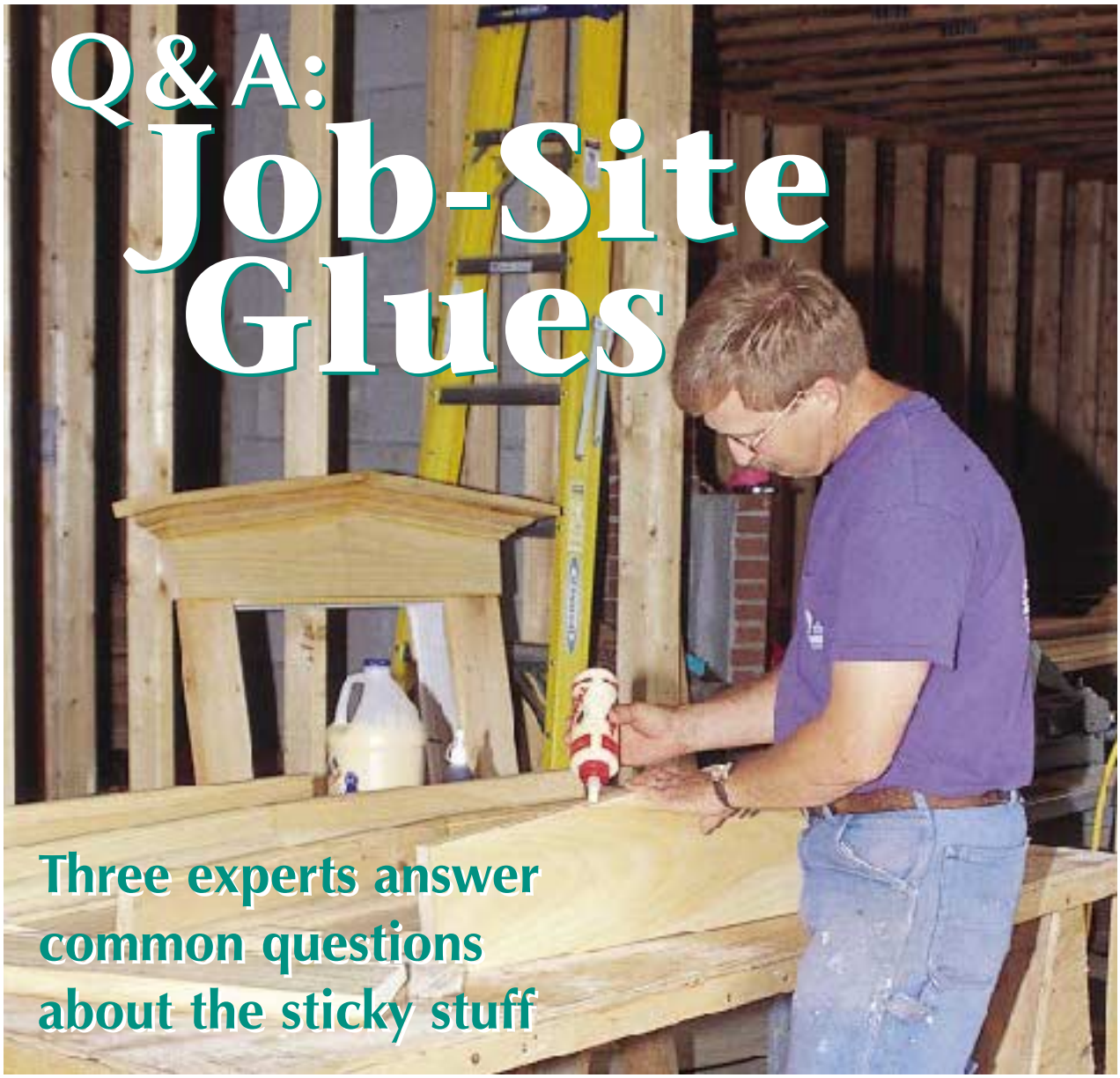
Q&A: Job-Site Glues



Three experts answer common questions about the sticky stuff

Most lumberyards and hardware stores sell a bewildering array of glues and adhesives, including construction adhesive, white glue, yellow glue, super glue, hot-melt glue, polyurethane glue, epoxy, and contact cement. So, how do you know which glue to reach for? Different materials require different glues, and choice is affected by whether the joint will be exposed to the weather, whether the materials are wet or dry, whether the joint can be clamped, the temperature during glue-up, and how long you can wait for the glue to cure.

For this article we went to three experts — Jeff Jewitt, Mark Roberts, and Jeff Pitcher — to answer some common questions about glues. Jeff Jewitt runs a restoration and finishing supply company. He is the author of *Great Wood Finishes,* and he has made two full-length feature videos, *Coloring Wood* and *Applying Top Coats* (for more information, go to www.homesteadfinishing.com). Mark A. Roberts is a technical specialist in Franklin International's Construction Products Division. Jeff Pitcher is the marketing director for Custom-Pak Adhesives in Newark, Ohio.

Q. *For gluing joints in interior wood trim that will never get wet, is white carpenter's glue as strong as yellow carpenter's glue?*

A. Yes. Both glues will form a bond stronger than the wood itself. The main difference between the two glues is in application characteristics.

Both glues belong to a class of glues called PVAs, because they are based on a resin called polyvinyl acetate. White glues like Elmer's were the first glues of this type to be introduced. While they are perfectly fine for gluing wood (and a host of other porous materials), they do not sand well, tend to run, and have low

initial tack. Yellow glues were developed to address these problems.

Yellow glues have a higher solids content (they are thicker than white glues and sand better) and have tackifiers added to speed assembly time. To distinguish these improved glues from the older white glues, manufacturers added a yellow color and a meaningless designation, calling them "aliphatic" resin glues.

If you think of yellow glue as white glue with a higher solids content, some additives and yellow color, you're on the right track. Yellow glues are definitely easier to use and have better application characteristics but are no different in strength from white glues.

— J.J.

Q. *If a joint assembled with yellow carpenter's glue freezes before it cures, will the joint lose its strength?*

A. Absolutely. The minimum application temperature for PVA glues, including yellow glue, is 50°F. While the glue itself can endure several freeze-thaw cycles, a joint with frozen glue will not develop a bond that's as strong as that in warmer temperatures. The glue will "chalk" at temperatures between 30°F and 40°F. Try it for yourself — glue some wood together and stick it in a freezer. The next day, you should be able to pull the joint apart by hand.

— J.J.

Q. *After a wood joint glued with yellow carpenter's glue has cured, is there any way to disassemble the joint?*

A. Both yellow and white PVAs will soften and lose some of their grip if you saturate the joint with hot vinegar. Use a syringe to introduce the hot vinegar. If necessary, drill 3/32-inch holes in an inconspicuous spot to get the hot vinegar into the joint. Let it sit for at least 30 minutes, and rewet the joint if it looks dry. Then try to wiggle the joint apart. Do not whack it with a hammer (at least, not very hard), as you run the risk of breaking the wood.

— J.J.

Q. *For gluing exterior wood trim components that will be exposed to the weather, but not submerged under water, what's best: resorcinol, epoxy, or a polyurethane glue?*

A. Any one of these will work, as long as the joint has good wood-to-wood contact. Personally, I think that epoxies and resorcinols have the best outdoor endurance qualities. For those joints that may be a bit loose, epoxy is the best, as it has the best structural and gap-filling qualities.

— J.J.

Although more expensive than white or yellow glue, polyurethane glue can be used on wet wood and forms a waterproof bond. Polyurethane glue can generally be used at a lower temperature than white or yellow glue.

White glue, like yellow glue, is a type of polyvinyl acetate glue. Yellow glues are thicker and easier to work with, set quicker, and are easier to sand when dry.

Cyanoacrylate glue is commonly referred to as super glue. It is very strong, and when used with an accelerator like Zip Kicker, it bonds almost instantly.

Q. *Is it possible for wood to be too wet for polyurethane glue?*

A. You can expect polyurethane glue to cure properly in woods with a moisture content of up to 25 percent. Moisture has to be present for polyurethane glue to cure, so the moisture content of the wood to be glued should be at least 8 percent. While there is no upper limit per se for the glue to cure, I'd avoid gluing wood with a moisture content higher than 25 percent, regardless of the glue. Wood with such a high moisture content will shrink appreciably, and the chances of joint failure are high.

— J.J.

Q. *What's the difference between polyurethane construction adhesive and polyurethane caulk? In a pinch, can polyurethane caulk be used as an adhesive?*

A. In a pinch — yes, but I wouldn't make a habit of it. While adhesives and caulks share the same resin (polyurethane), they are formulated for distinctly different purposes. In the case of wood, glues form the best bonds when they penetrate and wet the two parts, then cure to a hard, rigid solid. On the other hand, caulks are expected to "cling" to two surfaces (often of dissimilar materials) as well as to bulk up and fill the gap between them. This requires a less rigid and more elastomeric substance, so the caulk is loaded with fillers and additives that allow the caulk to move when the joint is stressed, then return to its original shape.

— J.J.

Q. *What is the best way to clean polyurethane adhesive from skin? How about from carpeting?*

A. The best idea is to wear gloves and not get it on your skin to begin with. I use cheap vinyl gloves from Grainger's. If polyurethane glue does get on your skin, wipe it immediately with a waterless hand cleaner. After it dries, the only way to remove it is to use an aggressive pumice-based hand cleaner, which will remove most of the glue (and part of your skin). The dried glue will wear off in about a week.

On carpeting, the last thing I would do is try to clean it by wiping it with anything containing water. Naphtha should remove the bulk of it, without initiating curing.

— J.J.

Q. *What glue works best with MDF?*

A. Just about anything, including PVAs, epoxy, and polyurethanes. However, because MDF tends to suck up aqueous glues, when edge-gluing solid wood to the edges of MDF, it's advisable to pretreat the MDF with Wood Size (available from Franklin) or Glue Size (available from Custom-Pak Adhesives) to minimize suck-up of the glue and a resulting poor bond.

— J.J.

Q. *Some builders use hot-melt glue for temporary jigs. Can hot-melt glue also be used for a permanent bond? What types of applications make sense for hot-melt glue?*

A. The use of hot-melt as a "permanent" adhesive has been debated. Personally, I don't use it for permanent bonds, but the furniture industry does, using it for a whole array of purposes, including edging and face-lamination of vinyl.

Hot-melt doesn't penetrate and "wet" a wooden surface the way other glues do, so the bond it forms isn't as rigid. Applications for which I would consider using hot-melt include gluing fabric and applying melamine edging to particleboard. One thing is for certain: The consumer grades are far different from the industrial grades used by the furniture industry.

— J.J.

Q. *What's the best glue to use for a wood joint when it is impossible to clamp the joint?*

A. If it's a structural joint, the best glue is epoxy, because it has the best gap-filling ability, without compromising overall joint strength. You still have to bring the two surfaces as close together as you can, so I'd use 5-minute epoxy and hold the parts together.

For nonstructural gluing (like gluing a rosette), my first choice is always cyanoacrylate glue, used with an activator. Use a thick-viscosity cyanoacrylate and apply it to one surface and the activator to the other. The big downside of the cyanoacrylates is that you need to get the fit right immediately, as the bond is instant and fussing with the fit will compromise the strength.

— J.J.

Q. *Which construction adhesives are best for gluing plywood subfloors to joists under wet conditions?*

A. All construction adhesives that are labeled AFG-01 and/or ASTM D 3498 are capable of doing the job. One of the tests to pass for these specifications is a wet lumber test. Solvent-based construction adhesives typically dissipate the water better than latex- and urethane-based adhesives.

— M.R.

Q. *What's the best wood glue for end-grain applications — miter joints, for example?*

A. This is one of the most difficult joints to glue. The epoxies and reactive hot-melts are better than water-based wood glues. (Reactive hot-melt glues are industrial glues that differ from typical hardware-store hot-melt glues.) Since the end grain of wood is very porous, water-based wood glues are easily absorbed into the grain, leaving little glue for bonding. A method for combating this is to thin some of the glue with water and use that to seal the end grain, then glue up as normal after an hour or so. There are some wood size products on the market that work to seal the end grain as well.

— M.R.

Q. *What's the best wood glue for less than ideal joints requiring gap filling?*

A. The best types of glues are the structural-rated glues, such as reactive hot-melts and epoxies. Typical water-based wood glues do not fill gaps.

— M.R.

Q. *What glue works best to fasten wood trim to drywall in a house with steel studs, where the baseboards and casings need to be glued?*

A. A heavy-duty construction adhesive will work fine in this application. However, I would still recommend the use of mechanical fasteners in the drywall for creep support.

— M.R.

Q. *What glues work best for repairing veneer over particleboard (for example, on a cabinet end panel)?*

A. A water-based wood glue and good even pressure will work fine for this application.

— M.R.

Q. *What type of glue is best for repairing laminate that is beginning to lift at the edge of a kitchen countertop?*

A. If the existing glue is contact cement (which is typical), then I would recommend using that. Just apply a generous amount of contact cement to both surfaces and allow it to dry, then press back into place. If wood glue was used, spread water-based wood glue in the lifted area and add pressure for a couple of hours or until the glue is dry.

— M.R.

Q. *What glue works best for the lifting edges of a vinyl floor?*

A. Most multi-purpose flooring adhesives will do a good job for this type of problem. (Multi-purpose flooring

continued on page 8

GLUE GLOSSARY

Acrylic glue is the best glue for melamine. This water-based glue is technically EVA (ethylene vinyl acetate). Two EVA glues are Roo Products' RooClear and Franklin Internationals' Titebond Melamine Glue. Although EVA can be used on many materials, including vinyl, rubber, metals, stone, and plastic, it is rarely used on anything but melamine, because it forms a soft bond with a tendency to creep.

Adhesive caulks like Gloucester's Phenoseal can be used to bond wood, fiberglass, carpeting, vinyl, tile, and concrete. Adhesive caulks are waterproof and do not require clamping. They are not as strong as most glues and are more expensive than most construction adhesives. Typical applications include attaching kitchen backsplashes and exterior trim.

Construction adhesives are thick glues that come in tubes and are applied with a caulk gun. Construction adhesives can be either solvent-borne or water-borne. Typical construction adhesives include Liquid Nails and OSI's PL400. A wide range of construction adhesives are available for a variety of applications. They are used to join wood, metal, plastics, and rigid foam to wood or concrete.

Contact cement is most often used to bond plastic laminate to a substrate like particleboard. However, contact cement can also be used to bond wood, hardboard, plaster, plastics, metal, drywall, and fiberglass. The bond is heat-resistant and water-resistant. To use contact cement, both surfaces are coated and allowed to dry until they are tacky. The surfaces are then pressed together, and they bond immediately without tight clamping. Because contact cement contains a flammable solvent, it cannot be used near an open flame.

Cross-linking PVA glue is a weather-resistant type of yellow glue. Cross-linking PVAs are very strong and versatile. Titebond II and Elmer's Weather-Tite are cross-linking PVA glues.

Cyanoacrylate glue, also called super glue, can bond a wide range of materials, including wood, veneers, rubber, plastics, and metals. Among its disadvantages are its high cost and low tolerance for shock. For an instant cure, add an accelerator like Zip Kicker. Cyanoacrylate is a good choice for quick repairs — for example, to repair a raised sliver on a cabinet or door.

Epoxy glues have two parts, a resin plus a hardener. They cure by an exothermic chemical reaction. Epoxy glues are expensive but form a very strong, waterproof, heat-resistant bond. Epoxy is excellent at filling gaps and requires only

There's more than one way to skin a cat: Although a bottle of yellow glue and a tube of construction adhesive will handle a great many gluing needs, there are times you might want to choose a special glue from the wide range available.

light clamping. Epoxy can bond a wide range of materials, including wood, fiberglass, concrete, glass, leather, and plastics. Epoxy is often used for anchoring masonry fasteners and repairing rotten wood.

Hide glue gets its strength from animal protein. It is made from bovine leftovers like hide, hooves, and bones. Hide glue's bond is not very resistant to moisture. Franklin's liquid hide glue is more convenient to use than traditional powdered hide glue, which needs to be heated for use. (Incidentally, the bull logo that Borden uses on Elmer's Glue-All has no connection to the production of hide glue. Elmer the Bull is a substitute for his mate, Elsie the Cow. Elsie was Borden's logo for its original glue, which was a casein glue made from skim milk.)

Hot-melt glue comes in solid sticks that are heated in an electric glue gun. Hot-melt glue is inexpensive and has gap-filling ability. It cures almost instantly and is more often used for temporary than permanent bonding.

Polyurethane glue is often used for exterior woodwork. It has almost no solvent content. It cures by chemical reaction with moisture present in the air or the materials being glued. As it cures, it foams, helping to fill gaps. Polyurethane glue can be used with wet wood and forms a strong waterproof bond. It stains the skin and is difficult or impossible to clean up. Gorilla Glue and Excel Glue are typical polyurethane glues.

Polyvinyl acetate (PVA) glues are a category of glues including common white and yellow glue. PVA glues are inexpensive and nontoxic.

Resorcinol glue is a two-part glue containing a liquid resin and a powdered hardener or catalyst. Like epoxy, resorcinol cures not by drying but by an exothermic chemical reaction. Resorcinol is a very durable, strong, heat-resistant, waterproof glue used for exterior applications. It has long been used for making wooden boats and airplanes. Among its disadvantages: It is relatively expensive, requires long clamping time at high pressure, and leaves a dark purple stain on wood. DAP Weldwood sells resorcinol glue.

Silicone caulk can be used as an adhesive. Silicone is suitable for exterior use and can be applied at temperatures as low as -55°F. Silicone can solve awkward bonding problems — for example, it is used to attach small access ramps to raised door thresholds.

Urea formaldehyde glues come either as a powder that is mixed with water (for example, DAP Weldwood plastic resin glue) or as a two-component glue (for example, Unibond 800). The glue develops its bond when urea and formaldehyde are mixed. Urea formaldehyde glue is very strong and inexpensive; however, it can only be used above 70°F and requires tight clamping.

White glue, which is a polyvinyl acetate glue, is a common inexpensive wood glue. Elmer's Glue-All is a typical white glue. Although white glue does not form a waterproof bond, it is cheap and very strong and is suitable for many interior applications. Unlike yellow glue, which has a shelf life of about a year, white glue will stay fresh for years in a sealed container. White glue cures by loss of moisture. One of the disadvantages of white glue is its tendency to gum up sandpaper.

Yellow carpenter's glue, like white glue, is a type of polyvinyl acetate glue. Typically, yellow glue is thicker and tackier than white glue. The use of yellow dye to distinguish improved varieties of PVA glue from the earlier white varieties is a manufacturer's convention; the color of the glue is no indication of its quality.

Most yellow glues are more resistant to solvents and heat than typical white glues. They are also less likely than white glues to clog sandpaper. Titebond is a typical yellow carpenter's glue.

THE GREAT GLUE TEST

We tested nine glues for strength: construction adhesive (MACCO's Liquid Nails heavy-duty construction adhesive), contact cement (DAP Weldwood), cross-linking PVA glue (Franklin International's Titebond II), cyanoacrylate (Pacer Technology's Zap-A-Gap), epoxy (System Three Quick Cure), hot-melt glue (generic general-purpose glue sticks), polyurethane glue (Gorilla Glue), white glue (Elmer's Glue-All), and yellow glue (Franklin International's Titebond).

The simple testing protocol used common tools, not laboratory testing apparatus. We glued together nine pairs of 2x4 blocks, 6 inches long, applying the glue to only 7 square inches of each test assembly. (Each 2x4 face received a 1-inch-wide strip of glue on either end.) Before the glue-up, each 2x4 block was fitted with a 1/4-inch eyebolt with a countersunk nut and washer (see Figure A). All of the glues were applied according to the manufacturer's instructions. After clamping for up to two hours, the blocks cured for five days at about 70°F.

The test was set up as a series of elimination rounds, somewhat like the TV show *Survivor.* In the first round

Figure A. Nine pairs of 2x4 blocks were fitted with eyebolts and glued together with different glues.

Figure B. The test blocks were suspended on a chain and gradually loaded with an increasing number of concrete blocks.

The Results: The Bonds That Held

Round One:	**Samples weighted with concrete blocks**
1st Glue Eliminated:	Contact cement (Failed when weighted with 3 blocks)
2nd Glue Eliminated:	Hot-melt glue (Failed when weighted with 4 blocks)
Round Two:	**After soaking underwater, samples weighted with concrete blocks**
3rd Glue Eliminated:	Construction adhesive (Failed when weighted with 4 blocks)
Round Three:	**Samples linked together and pulled apart with a come-along**
4th Glue Eliminated:	White glue
5th Glue Eliminated:	Epoxy
The Winners:	**Titebond, Titebond II, polyurethane glue, and cyanoacrylate**

Figure C. The first test sample to fail was glued with contact cement. The joint began to separate when loaded with three concrete blocks.

of testing, each of the nine test assemblies was suspended on a chain and weighted with an increasing number of 42-pound concrete blocks, up to a total of four blocks (Figure B). This round eliminated two glues (Figure C).

For the second round of testing, the surviving seven test assemblies were soaked underwater for 24 hours. Then they were again weighted with an increasing number of concrete blocks (up to five). This round eliminated one glue.

In the final, brutal round of testing, the six surviving samples were linked together, chained to a maple tree, and pulled apart with a come-along. Two glues were eliminated by this test. When the hardware failed (the eyebolts eventually opened up), the test was declared over, leaving four winners (Figure D).

Although this test was intended to measure glue strength, it must be emphasized that the strongest possible glue is not always the best glue. A glue only needs to be strong enough to perform the job it's used for. Furthermore, if a glued joint never gets wet, strength after soaking is irrelevant.

Nevertheless, some general conclusions can be made. Common hot-melt glue forms a relatively weak bond. Household white glue is surprisingly strong, even after 24 hours underwater. And yellow glue, polyurethane, and super glue are so strong that in most cases, the materials themselves, or the hardware attached to them, will fail before the glue joint.

— Martin Holladay

Figure D. The last six glue samples were fastened to a maple tree and tugged with a come-along (right). Two failed, while four survived until the eyebolts deformed (above).

continued from page 4

adhesives are available in quart, gallon, and 4-gallon pails at most hardware stores and lumberyards.) Just lift the edge, apply the adhesive, then press the vinyl back in place and weight the area until the adhesive dries.

— M.R.

Q. *What is the best glue for fastening bathroom accessories to ceramic tile walls?*

A. A solvent-based construction adhesive will work fine for attaching ceramic fixtures. For best results, I recommend abrading the glazing on the tile first. For attaching plastic fixtures, a multi-purpose construction adhesive works well. A 100% silicone caulk also would work. Silicones by nature are very strong. Once the tile is in place and the adhesive is dry, caulking around the fixture is recommended.

— M.R.

Q. *Are the terms "water-resistant" and "waterproof" based on any technical standards?*

A. The terms are probably based loosely on the HPVA specifications for water resistance. The HPVA (Hardwood Plywood Veneer Association) set up the designations Type I, Type II, and Type III to denote degrees of water resistance. The Type I designation undergoes the most strenuous testing and can be considered to mean "waterproof." Type II testing is less strenuous and can be considered to mean "water resistant." Type III would not be considered water resistant.

It is important to note that such testing is intended for plywood only and doesn't really have a lot of meaning outside of plywood gluing. The ASTM has set up similar specifications for determining water resistance. Joints that pass their "wet use" specification are considered to be waterproof. Other industries such as the door industry use other specifications in determining water resistance.

— J.P.

Q. *I've heard that an adhesive caulk does not bond as strongly as glue. Is an adhesive caulk like Phenoseal strong enough to attach a kitchen backsplash to drywall?*

A. Normally, an adhesive caulk wouldn't be as strong as glue, but they are really intended for different purposes. Glue should be used in cases where two surfaces can be brought into intimate contact and held there under pressure for an extended amount of time. Often, this just isn't possible on the job site. Thus, the reason for adhesive caulks and mastic adhesives: They have a gap-filling ability not available with traditional yellow or white glue.

Adhesive caulk should certainly be strong enough to adhere a backsplash to drywall. The limiting factor is really the strength of the drywall.

— J.P.

Q. *Can silicone caulk be used as an exterior glue? How does it compare in strength to Titebond II or a polyurethane glue?*

A. The simple answer to the first question is yes, silicone caulk could be used as an exterior glue. However, because it's not actually an adhesive, its adhesive qualities tend to break down much sooner than those of an actual adhesive.

In comparing different exterior adhesives, it's best to look at longevity rather than strength. Initially, any good exterior adhesive should be stronger than the material it is gluing. Over time, with exposure to extremes of heat and cold as well as moisture, the glue line begins to deteriorate. Most one-part cross-linking adhesives (for example, Titebond II) have a limited ability to withstand the extremes encountered in an exterior environment. Most will show signs of delamination within 6 to 12 months. Reactive polyurethanes tend to have better longevity — sometimes as much as five or six years. For the ultimate exterior bond, the unquestioned best adhesive is a resorcinol resin. In documented cases of over 60 years, this type of glue still remains durable.

— J.P.

Q. *What is the best exterior wood glue to use in below-freezing temperatures?*

A. Polyurethane glues are the best exterior wood glues to use in colder temperatures. Most water-based products like cross-linking PVAs have a minimum-use temperature (some as high as 60°F). Because reactive polyurethanes are 100% solids, there is no concern with minimum-use temperatures. In fact, tests have shown that the bond strength with some polyurethane adhesives actually increases as the temperature drops. Although most polyurethane glue manufacturers recommend that their glues be applied above a minimum temperature (usually 32°F or 40°F), they can probably be used at lower temperatures.

— J.P.

Q. *Are there differences in performance between water-borne and solvent-borne construction adhesives?*

A. Yes, solvent-based products tend to have a much faster curing rate, as well as a faster dry-down rate. They also have the ability to "wet out" some surfaces that a strictly water-borne product might not be capable of doing. An adhesive's ability to wet out a

surface is directly related to the ultimate performance of the glue line.

"Wetting out" is best explained using the analogy of waxing a car. If a car has been recently waxed, water will tend to bead on the surface. On the other hand, if it has been some time since a car has been waxed, water will form a film on the surface. At this point, the water is said to be wetting out the surface of the car.

It's important to remember that most water-borne construction adhesives contain at least some percentage of solvent, which can often aid in their wetting ability.

— J.P.

Q. *Are there any water-borne glues that are water-resistant?*

A. Yes, all cross-linking PVAs such as Titebond II are water-based, as are urea resins and even resorcinol resins. Any of these adhesives will provide varying degrees of water resistance.

— J.P.

Q. *Some trim carpenters use a dab of hot-melt glue in the center of a joint bonded with yellow carpenter's glue, so that the hot-melt glue holds the trim pieces together without clamping. Will such a joint be as strong as a clamped joint?*

A. No. A clamped joint will always be stronger than one held together with a dab of hot-melt. For the best possible bond, the pieces being glued need to be held in intimate contact while under pressure. Any other method will result in a bond of less strength. This is due to the thickness of the resulting bond. As a rule, a thick glue line is a weak glue line. This said, chances are that the carpenters who use the hot-melt method probably achieve a strong enough joint for their intended purpose.

— J.P.

GLUE MANUFACTURERS

Abatron
800/445-1754
www.abatron.com
BestBond polyurethane glue

AmBel
800/779-3935
www.excelglue.com
Distributor of Excel polyurethane glue, which is made in Belgium by Rectavit

Elmer's Products
888/435-6377
www.elmers.com
Elmer's Glue-All, Elmer's Weather-Tite glue

Custom-Pak Adhesives
800/454-4583
www.custompak.com
Resorcinol, white and yellow glues

DAP Inc.
800/543-3840
www.dap.com
Weldwood contact cement, urea formaldehyde glue, resorcinal glue, and construction adhesives

Franklin International
800/877-4583
www.titebond.com
Titebond, Titebond II, Liquid Hide Glue, contact cement, and construction adhesives

Gloucester
800/343-4963
www.phenoseal.com
Phenoseal adhesive caulk

Gougeon Brothers
517/684-7286
www.westsystem.com
West System epoxy glue

Lutz File & Tool
800/966-3458
www.gorillaglue.com
Gorilla polyurethane glue

MACCO
800/634-0015
www.liquidnails.com
Liquid Nails

OSI Sealants
800/321-3578
www.osisealants.com
PL400

Pacer Technology
800/538-3091
www.pacertech.com
Zap-A-Gap and Zip Kicker

Roo Products
877/766-4583
www.rooglue.com
RooClear acrylic glue, RooTac contact cement, RooWood aliphatic resin glue

System Three Resins
800/333-5514
www.systemthree.com
Quick Cure epoxy

Vacuum Pressing Systems
207/725-0935
www.vacupress.com/veneerglue.htm
Unibond 800